

Final

**Remedial Investigation Report
Range J – Pelham Range, Parcel 202(7)**

**Volume I of II
Text and Appendices A through C**

**Fort McClellan
Calhoun County, Alabama**

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**Task Order CK05
Contract No. DACA21-96-D-0018
Shaw Project No. 774645**

September 2004

Revision 1

Table of Contents

	Page
List of Appendices	vi
List of Tables.....	vii
List of Figures	viii
Executive Summary	ES-1
1.0 Introduction	1-1
1.1 Scope and Objectives.....	1-1
1.2 Site Background.....	1-2
1.2.1 FTMC Site Description and History.....	1-2
1.2.2 Range J Site Description and History.....	1-5
1.2.3 Previous Investigations.....	1-7
1.3 Report Organization.....	1-10
2.0 Study Area Investigation	2-1
2.1 UXO and Chemical Agent Surveys.....	2-1
2.1.1 Surface UXO Survey	2-1
2.1.2 Downhole UXO and Chemical Agent Survey.....	2-1
2.2 Geophysical Survey	2-2
2.3 Environmental Sampling	2-2
2.3.1 Surface Soil Sampling	2-2
2.3.2 Subsurface Soil Sampling.....	2-3
2.3.3 Drum Sampling.....	2-4
2.3.4 Monitoring Well Installation	2-4
2.3.4.1 Residuum Monitoring Wells.....	2-4
2.3.4.2 Bedrock Monitoring Wells	2-5
2.3.4.3 Well Development.....	2-6
2.3.5 Water Level Measurements	2-7
2.3.6 Groundwater Sampling.....	2-7
2.3.7 Slug Testing	2-7
2.4 Surveying of Sample Locations.....	2-8
2.5 Analytical Program	2-8
2.6 Sample Preservation, Packaging, and Shipping.....	2-9

Table of Contents (Continued)

	Page
2.7 Investigation-Derived Waste Management and Disposal	2-9
2.8 Variances/Nonconformances	2-10
2.9 Data Quality	2-10
3.0 Physical Characteristics of Study Area	3-1
3.1 Demography and Land Reuse	3-1
3.2 Meteorology	3-1
3.3 Physiography	3-2
3.4 Sensitive Environments	3-3
3.4.1 Wetlands	3-3
3.4.2 Sensitive Habitats	3-4
3.4.3 Threatened and Endangered Species	3-4
3.5 Soils	3-5
3.5.1 Site-Specific Soils	3-5
3.6 Geology	3-6
3.6.1 Regional Geology	3-6
3.6.2 Site-Specific Geology	3-10
3.7 Surface Water Hydrology	3-11
3.7.1 Regional Surface Water Hydrology	3-11
3.7.2 Site-Specific Surface Water Hydrology	3-13
3.8 Hydrogeology	3-13
3.8.1 Regional Hydrogeology	3-13
3.8.2 Site-Specific Hydrogeology	3-15
3.8.2.1 Groundwater Flow	3-15
3.8.2.2 Aquifer Characteristics	3-16
4.0 Nature and Extent of Contamination	4-1
4.1 Geophysical Survey Results	4-1
4.2 Sources of Contamination	4-1
4.3 Summary of Analytical Results	4-1
4.3.1 Surface Soil Analytical Results	4-2
4.3.2 Subsurface Soil Analytical Results	4-4
4.3.3 Groundwater Analytical Results	4-6
4.3.4 Drum Sample Analytical Results	4-9

Table of Contents (Continued)

	Page
5.0 Contaminant Fate and Transport.....	5-1
5.1 Introduction.....	5-1
5.2 Potential Routes of Migration.....	5-1
5.2.1 Dust Emission and Volatilization	5-2
5.2.2 Erosion and Surface Water Runoff.....	5-2
5.2.3 Surface Water and Sediment Transport	5-2
5.2.4 Leaching from Surface and Subsurface Soils to Groundwater.....	5-3
5.2.5 Groundwater Transport.....	5-3
5.2.6 Discharge of Groundwater to the Surface.....	5-4
5.2.7 Bioaccumulation	5-4
5.3 Contaminant Persistence.....	5-4
5.3.1 Chemical and Physical Processes Affecting Fate and Transport.....	5-4
5.3.1.1 Aqueous Solubility.....	5-5
5.3.1.2 Volatilization.....	5-5
5.3.1.3 Diffusion	5-5
5.3.1.4 Adsorption/Desorption.....	5-6
5.3.1.5 Degradation Rate	5-6
5.3.2 Contaminant Fate and Transport.....	5-7
5.3.2.1 Volatile Organic Compounds	5-7
5.3.2.2 Semivolatile Organic Compounds	5-8
5.3.2.3 Inorganics.....	5-9
5.4 Contaminant Migration.....	5-11
5.4.1 Processes Involved in Solute Transport.....	5-11
5.4.1.1 Advection.....	5-11
5.4.1.2 Dispersion	5-11
5.4.1.3 Diffusion	5-12
5.4.1.4 Retardation.....	5-12
5.4.2 Migration of Contaminants	5-13
6.0 Streamlined Human Health Risk Assessment.....	6-1
6.1 Introduction	6-1

Table of Contents (Continued)

	Page
6.2 Streamlined Risk Assessment Protocol	6-1
6.2.1 Develop a Conceptual Site Exposure Model.....	6-1
6.2.2 Select Site-Related Chemicals	6-2
6.2.3 Select Chemicals of Potential Concern	6-2
6.2.4 Characterize Risk	6-2
6.2.5 Identify Chemicals of Concern	6-3
6.2.6 Develop Remedial Goal Options.....	6-3
6.3 Results.....	6-3
6.3.1 Surface Soil	6-4
6.3.2 Groundwater.....	6-5
6.3.3 Total Soil.....	6-7
6.3.4 Future Groundwater Conditions.....	6-8
6.3.5 Uncertainty Analysis.....	6-9
6.3.6 Conclusions	6-11
7.0 Screening-Level Ecological Risk Assessment.....	7-1
7.1 Introduction	7-1
7.2 Environmental Setting.....	7-1
7.3 Constituents Detected On Site	7-3
7.4 Site Conceptual Model.....	7-3
7.4.1 Constituent Fate and Transport	7-4
7.4.1.1 Fate and Transport in Soil	7-4
7.4.1.2 Fate and Transport in Surface Water.....	7-5
7.4.1.3 Fate and Transport in Sediment	7-5
7.4.2 Ecotoxicity	7-5
7.4.2.1 Arsenic	7-6
7.4.2.2 Chromium.....	7-8
7.4.2.3 Iron	7-10
7.4.2.4 Mercury	7-11
7.4.2.5 Vanadium	7-14
7.4.2.6 Zinc.....	7-16

Table of Contents (Continued)

	Page
7.4.2.7 Acetone.....	7-18
7.4.3 Potential Receptors.....	7-20
7.4.3.1 Herbivorous Feeding Guild.....	7-20
7.4.3.2 Invertivorous Feeding Guild.....	7-21
7.4.3.3 Omnivorous Feeding Guild.....	7-21
7.4.3.4 Carnivorous Feeding Guild.....	7-22
7.4.4 Complete Exposure Pathways.....	7-23
7.5 Screening-Level Risk Estimation.....	7-24
7.5.1 Ecological Screening Assessment Endpoints.....	7-25
7.5.2 Ecological Screening Values.....	7-25
7.5.3 Determination of Exposure Point Concentrations.....	7-26
7.5.4 Screening-Level Hazard Quotients.....	7-26
7.6 Identification of Constituents of Potential Ecological Concern.....	7-29
7.7 Uncertainty Analysis.....	7-32
7.8 Summary and Conclusions.....	7-34
7.8.1 SLERA Summary.....	7-34
7.8.2 Conclusions of SLERA.....	7-35
8.0 Summary, Conclusions, and Recommendations.....	8-1
8.1 Summary and Conclusions.....	8-1
8.1.1 Geophysical Survey.....	8-1
8.1.2 Geological and Hydrogeological Data.....	8-1
8.1.3 Surface and Subsurface Soil Contaminant Distribution.....	8-1
8.1.4 Groundwater Contaminant Distribution.....	8-2
8.1.5 Streamlined Human Health Risk Assessment.....	8-2
8.1.6 Screening-Level Ecological Risk Assessment.....	8-3
8.2 Recommendations.....	8-3
9.0 References.....	9-1

Attachment 1 – List of Abbreviations and Acronyms

List of Appendices

- Appendix A – Geophysical Survey Report
- Appendix B – Sample Collection Logs and Analysis Request/Chain-of-Custody Records
- Appendix C – Boring Logs and Well Construction Logs
- Appendix D – Well Development Logs
- Appendix E – Slug Testing Methodology and Results
- Appendix F – Survey Data
- Appendix G – Variance Reports
- Appendix H – Summary of Validated Analytical Data
- Appendix I – Data Validation Summary Reports
- Appendix J – Summary Statistics for Background Media, Fort McClellan, Alabama
- Appendix K – Statistical and Geochemical Evaluation of Metals Data
- Appendix L – Risk Assessment Supporting Documentation

List of Tables

Table	Title	Follows Page
1-1	VOCs Detected in Groundwater During 1994/1995 Remedial Investigation	1-9
2-1	Sampling Locations and Rationale	2-2
2-2	Soil Sample Designations and Analytical Parameters	2-3
2-3	Drum Sample Designation and Analytical Parameters	2-4
2-4	Monitoring Well Construction Summary	2-4
2-5	Groundwater Elevations	2-7
2-6	Groundwater Sample Designations and Analytical Parameters	2-7
2-7	Groundwater Field Parameters	2-7
2-8	Variances to the Site-Specific Field Sampling Plans	2-10
3-1	Horizontal Hydraulic Gradients	3-16
3-2	Vertical Hydraulic Gradients	3-16
3-3	Summary of Hydraulic Conductivities	3-16
4-1	Surface Soil Analytical Results	4-2
4-2	Subsurface Soil Analytical Results	4-2
4-3	Groundwater Analytical Results	4-2
5-1	Physical and Chemical Parameters Affecting Environmental Fate of Organic Chemicals	5-1
5-2	Distribution Coefficient, K_d	5-1
5-3	Contaminant Migration Rates	5-1
7-1	Feeding Guilds and Exposure Pathways for Terrestrial Ecosystems	7-24
7-2	Constituents of Potential Ecological Concern in Surface Soil	7-26

List of Figures

Figure	Title	Follows Page
1-1	Installation Restoration Program Flow Chart	1-1
1-2	Regional Location Map	1-2
1-3	Site Location Map	1-5
1-4	Site Map	1-5
1-5	Soil Sample Locations, 1992 and 1995 SAIC Investigations	1-8
1-6	VOCs Detected in Groundwater, 1995 SAIC Investigation	1-9
2-1	Extent of Geophysical Survey Area	2-2
2-2	Soil and Drum Sample Locations	2-2
2-3	Monitoring Well Locations	2-2
3-1	2001 Precipitation and Average Annual Precipitation, Anniston, Alabama	3-2
3-2	Topographic Map	3-3
3-3	Geologic Cross Section A-A'	3-10
3-4	Geologic Cross Section B-B'	3-10
3-5	Cross Section Location Map	3-10
3-6	Surface Water Hydrology and Drainage Basins, Pelham Range	3-12
3-7	Groundwater Elevation Map, Residuum Monitoring Wells, June 13, 2001	3-15
3-8	Groundwater Elevation Map, Bedrock Monitoring Wells, June 13, 2001	3-15
3-9	Groundwater Elevation Map, Residuum Monitoring Wells, October 2, 2001	3-15
3-10	Groundwater Elevation Map, Bedrock Monitoring Wells, October 2, 2001	3-15
4-1	Geophysical Interpretation Map	4-1
4-2	Isoconcentration Map, Carbon Tetrachloride in Subsurface Soil	4-5
4-3	VOCs Exceeding SSSLs in Residuum Groundwater	4-7
4-4	VOCs Exceeding SSSLs in Bedrock Groundwater	4-7
4-5	Zone Divisions Based on Screened Intervals	4-8
4-6	Isoconcentration Map, Total VOCs in Groundwater (Zone A)	4-8
4-7	Isoconcentration Map, Total VOCs in Groundwater (Zone B)	4-8
4-8	Isoconcentration Map, Total VOCs in Groundwater (Zone C)	4-8
4-9	Isoconcentration Map, Chlorinated VOCs in Groundwater (Zone A)	4-8
4-10	Isoconcentration Map, Chlorinated VOCs in Groundwater (Zone B)	4-8
4-11	Isoconcentration Map, Chlorinated VOCs in Groundwater (Zone C)	4-8
4-12	Isoconcentration Map, Carbon Tetrachloride in Groundwater (Zone A)	4-8

List of Figures (Continued)

Figure	Title	Follows Page
4-13	Isoconcentration Map, Carbon Tetrachloride in Groundwater (Zone B)	4-8
4-14	Isoconcentration Map, Carbon Tetrachloride in Groundwater (Zone C)	4-8
5-1	Geologic Cross-Section A-A', Total VOCs	5-14
5-2	Geologic Cross Section B-B', Total VOCs	5-14
5-3	Geologic Cross Section A-A', Chlorinated VOCs	5-14
5-4	Geologic Cross Section B-B', Chlorinated VOCs	5-14
5-5	Geologic Cross-Section A-A', Carbon Tetrachloride	5-14
5-6	Geologic Cross-Section B-B', Carbon Tetrachloride	5-14
7-1	Site Conceptual Model	7-3

Executive Summary

In accordance with Contract Number DACA21-96-D-0018, Task Order CK05, Shaw Environmental, Inc. completed a remedial investigation (RI) at Range J – Pelham Range, Parcel 202(7), at Fort McClellan in Calhoun County, Alabama. The RI was conducted to determine the nature and extent of contamination at the site and to assess future risks to human health and the environment.

Range J is a former chemical agent training and disposal area located in the north-central portion of Pelham Range. The site includes a chain-link fenced area approximately 150 feet long by 60 feet wide (0.2 acre). Range J was reportedly used until 1963 for chemical agent training, including agent use, detection, chemical waste disposal, and use of chemical decontaminants. Chemicals used as decontaminants included organic or inorganic materials. Inorganic materials included bleach in various forms, calcium hypochlorite, and chlorine itself. Organic compounds included the chloroamides and closely related compounds. These compounds were usually dissolved in an organic solvent (e.g., carbon tetrachloride or 1,1,2,2-tetrachloroethane [PCA]). The fenced area was also reportedly used to dispose of drummed decontaminated soil.

Previous investigations at Range J indicated that contamination is present at the site as a result of historical Army activities. In particular, organic solvents (i.e., carbon tetrachloride, 1,1,2,2-PCA, tetrachloroethene [PCE], and trichloroethene) were detected in groundwater at concentrations that warranted further investigation. These contaminants are believed to be associated with the chemical agents and decontaminants used at the site.

The RI conducted by Shaw Environmental, Inc. at Range J consisted of the collection and analysis of 32 surface soil samples, 34 subsurface soil samples, and 46 groundwater samples. A geophysical survey was performed to identify potential drum disposal areas. However, no geophysical anomalies representing buried drums or other potential source areas were identified within the area of the survey. A total of 28 residuum and bedrock groundwater monitoring wells were installed at the site to facilitate groundwater sample collection and to provide site-specific geological and hydrogeological characterization information. Samples collected during the RI were analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), metals, and chemical warfare material breakdown products. Additionally, the groundwater samples were analyzed for selected water quality parameters.

In soils, several metals were detected at concentrations exceeding residential human health site-specific screening levels (SSSL), ecological screening values (ESV), and background screening values. VOC and SVOC concentrations in soils were below SSSLs and ESVs except for acetone in one surface soil sample, which was below its SSSL but exceeded its ESV. Carbon tetrachloride and chloroform were detected in approximately 20 percent of the subsurface soil samples; however, the concentrations of these compounds were well below SSSLs. Chemical warfare material breakdown products were not detected in site media.

Although a few metals were detected in groundwater at concentrations exceeding SSSLs and background concentrations, the statistical and geochemical evaluation of the data concluded that the metals are naturally occurring. Seven VOCs were detected in groundwater at concentrations exceeding their respective SSSLs: benzene, 1,1,2,2-PCA, 1,2-dichloroethane (DCA), carbon tetrachloride, chloroform, PCE, and trichloroethene. The horizontal and vertical extent of these contaminants in groundwater was defined.

The geology at Range J is characterized as clayey sand to sandy clay residuum overlying fractured and vuggy dolomite. No geologic faults were identified in the wells, and none are mapped within the area. Groundwater elevation data show an overall westward flow direction in both the residuum and bedrock wells. Vertical hydraulic gradients indicate a downward flow between the residuum and bedrock, supporting connectivity. The horizontal hydraulic gradients in both residuum and bedrock are very low, with less than a foot of elevation difference across the site. Average linear groundwater flow velocity was calculated at approximately 0.01 foot per day for the residuum and approximately 0.1 foot per day for the bedrock.

The distribution of organic contaminants in groundwater does not indicate a distinct relationship between plume migration and groundwater flow direction. Calculated linear velocities appear to be too low to adequately account for contaminant transport and distribution by advective transport alone. Dispersion and diffusion in the residuum and the effect of fracture flow and solution porosity in the bedrock may be the dominant transport mechanisms.

A streamlined human health risk assessment (SRA) evaluated three receptor scenarios: resident, National Guardsperson, and recreational site user. The SRA identified six VOCs (1,1,2,2-PCA, 1,2-DCA, benzene, carbon tetrachloride, chloroform, and PCE) as chemicals of concern (COC) for the resident exposed to groundwater at the site. For the National Guardsperson, the SRA identified the following COCs in groundwater: 1,2-DCA, benzene, carbon tetrachloride, and chloroform. No chemicals of potential concern were identified for the recreational site user. The

SRA concluded that 1,2-DCA, benzene, and carbon tetrachloride are present in groundwater at levels that pose an unacceptable threat to human health. Of these compounds, the main risk driver for groundwater at Range J is carbon tetrachloride. No COCs were identified in soils.

A screening-level ecological risk assessment identified six metals (arsenic, chromium, iron, mercury, vanadium, and zinc) and four VOCs (acetone, bromomethane, cumene, and p-cymene) as constituents of potential ecological concern (COPEC) in surface soil. The metals, however, were determined to be present at naturally occurring levels based on statistical and geochemical evaluation. Furthermore, the VOCs were ultimately excluded as COPECs based on additional lines of evidence. Therefore, the screening-level ecological risk assessment concluded that none of the COPECs present an unacceptable risk to the terrestrial ecosystem at Range J.

Based on the results of the RI, no further actions are warranted with respect to defining the extent of contamination in soils. A focused feasibility study or interim removal action is recommended, however, for groundwater.

1.0 Introduction

The U.S. Army has selected Fort McClellan (FTMC), located in Calhoun County, Alabama, for closure by the Base Realignment and Closure (BRAC) Commission under Public Laws 100-526 and 101-510. The 1990 Base Closure Act, Public Law 101-510, established the process by which U.S. Department of Defense (DOD) installations would be closed or realigned. The BRAC Environmental Restoration Program requires investigation and cleanup of federal properties prior to transfer to the public domain. The U.S. Army is conducting environmental studies of the impact of suspected contaminants at parcels at FTMC under the management of the U.S. Army Corps of Engineers (USACE)-Mobile District. The USACE contracted Shaw Environmental, Inc. (Shaw) (formerly IT Corporation [IT]) to complete the remedial investigation (RI) of Range J – Pelham Range, Parcel 202(7), under Contract Number DACA21-96-D-0018, Task Order CK05.

1.1 Scope and Objectives

The scope of the Range J RI is outlined in the supplemental RI work plan (IT, 1998a). The work plan includes the site-specific field sampling plan (SFSP) and the site-specific safety and health plan (SSHP), which were prepared to provide technical guidance for sample collection and analysis at Range J. The SFSP was used in conjunction with the SSHP as attachments to the installation-wide work plan (IT, 1998b, 2002a) and the installation-wide sampling and analysis plan (SAP) (IT, 2000a, 2002b). The SAP includes the installation-wide safety and health plan and quality assurance plan. RI field activities included a geophysical survey, completion of soil borings, installation of monitoring wells, and collection and analysis of soil and groundwater samples.

The primary objectives of this RI are to determine the nature and extent of contamination at Range J and to conduct a streamlined human health risk assessment (SRA) and screening-level ecological risk assessment (SLERA) to characterize the risk to potential human and ecological receptors. Completion of these objectives enables the support under the Installation Restoration Program (IRP) process of one or more of the four decisions presented below and in Figure 1-1.

- Preparation of an Engineering Evaluation and Cost Analysis to identify remedial action objectives and evaluate removal alternatives
- Preparation of a Feasibility Study or Focused Feasibility Study for evaluation of potential remedial measures

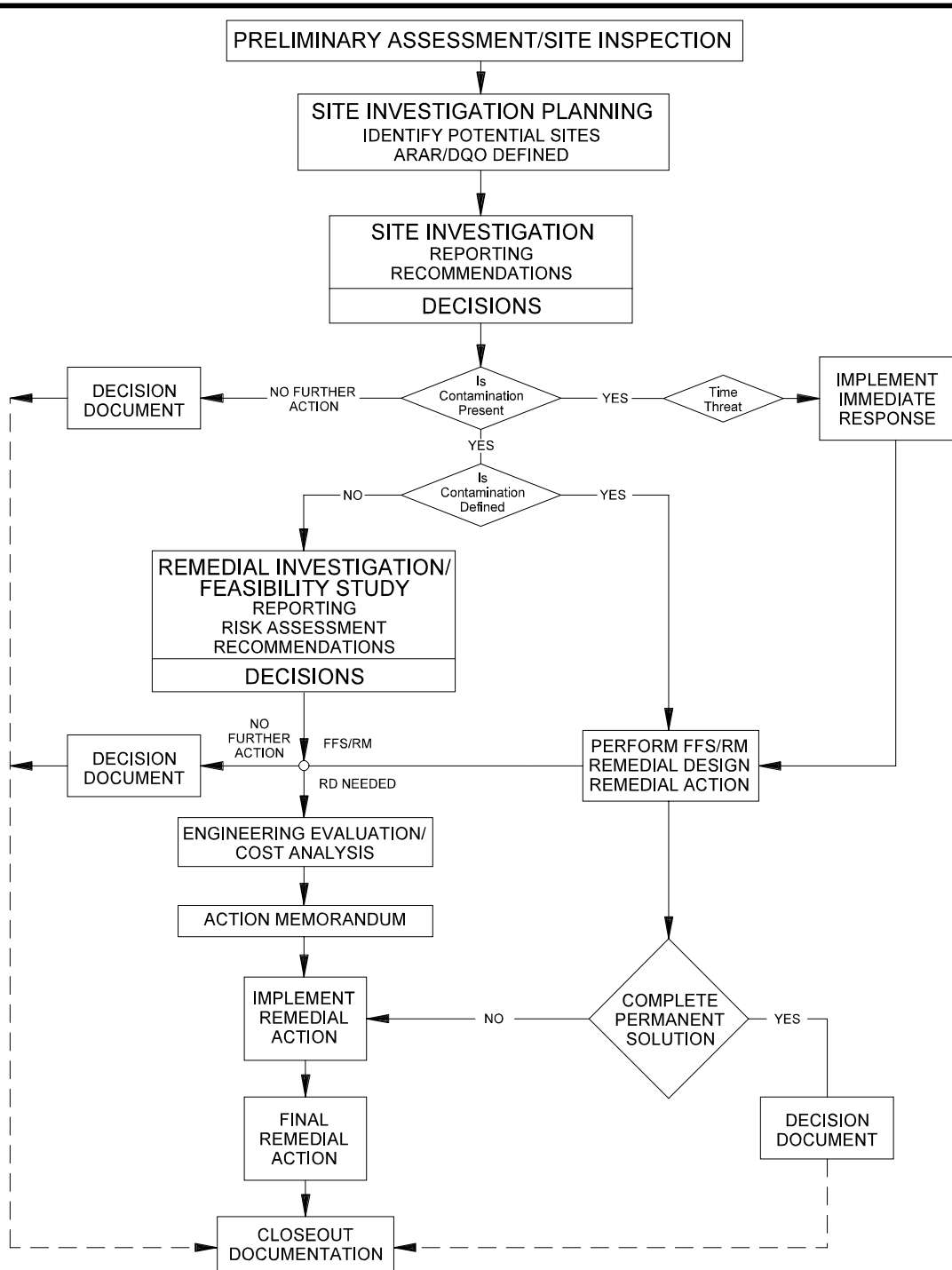


FIGURE 1-1
INSTALLATION RESTORATION
PROGRAM FLOW CHART
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
 MOBILE DISTRICT
 FORT McCLELLAN
 CALHOUN COUNTY, ALABAMA
 Contract No. DACA21-96-D-0018

LEGEND:

- ARAR APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
- DQO DATA QUALITY OBJECTIVES
- FFS/RM FOCUSED FEASIBILITY STUDY/ REMEDIAL MEASURE
- RD REMEDIAL DESIGN
- RI/FS REMEDIAL INVESTIGATION/ FEASIBILITY STUDY

- Recommendation of interim remedial measures
- Preparation of a Decision Document to support no further investigation actions.

1.2 Site Background

The following sections provide site background information for both FTMC and Range J, including previous investigations at Range J.

1.2.1 FTMC Site Description and History

FTMC is a U. S. Army facility under the control of the U. S. Army Training and Doctrine Command (TRADOC) that was closed under the Base Realignment and Closure (BRAC) program in September 1999. FTMC was a U.S. Army training installation located in northeast Alabama, near the city of Anniston in Calhoun County (Figure 1-2). FTMC consisted of three portions of land: Main Post, Choccolocco Corridor, and Pelham Range.

The majority of FTMC development is in the northwest area of the Main Post. The City of Anniston is located to the south and west of the Main Post; adjoining the Main Post installation to the east are the Choccolocco Mountains of the Talladega National Forest. The Main Post, consisting of 18,929 acres, was purchased by the federal government in March 1917 for the construction of a National Guard camp (Camp McClellan). Pistol and rifle ranges were established north of the camp, automatic rifle and machine gun ranges were established southwest of the camp, and artillery firing ranges were established southeast of the camp toward the Choccolocco Mountains (New South Associates, Inc. [NSA], 1993). Camp McClellan expanded throughout the 1920s and 1930s. The advent of World War II in the 1940s brought continued growth for the installation. Most notably, the 22,245 acres of Pelham Range were purchased to the west of the Main Post in early 1940 for artillery, tank, and heavy mortar firing. Approximately 4,488 additional acres to the east of the Main Post (Choccolocco Corridor) were leased from the State of Alabama to connect the Main Post to the Talladega National Forest (CH2M Hill, 1994). Historically, Choccolocco Corridor was used for various range training activities. The lease was terminated in May 1998.

The post-war period initially brought a decline in operations at FTMC. A decrease in military spending placed the installation on inactive status. However, in 1950 the installation was reinstated to active status because of the Korean Conflict. The U.S. Army Chemical School was established at FTMC in 1951; the large outdoor training areas allowed for specialized chemical training involving chemical warfare protection, decontamination procedures, flame throwers, and the operation of smoke generators. The Base hospital was renovated to specialize in chest diseases. The first

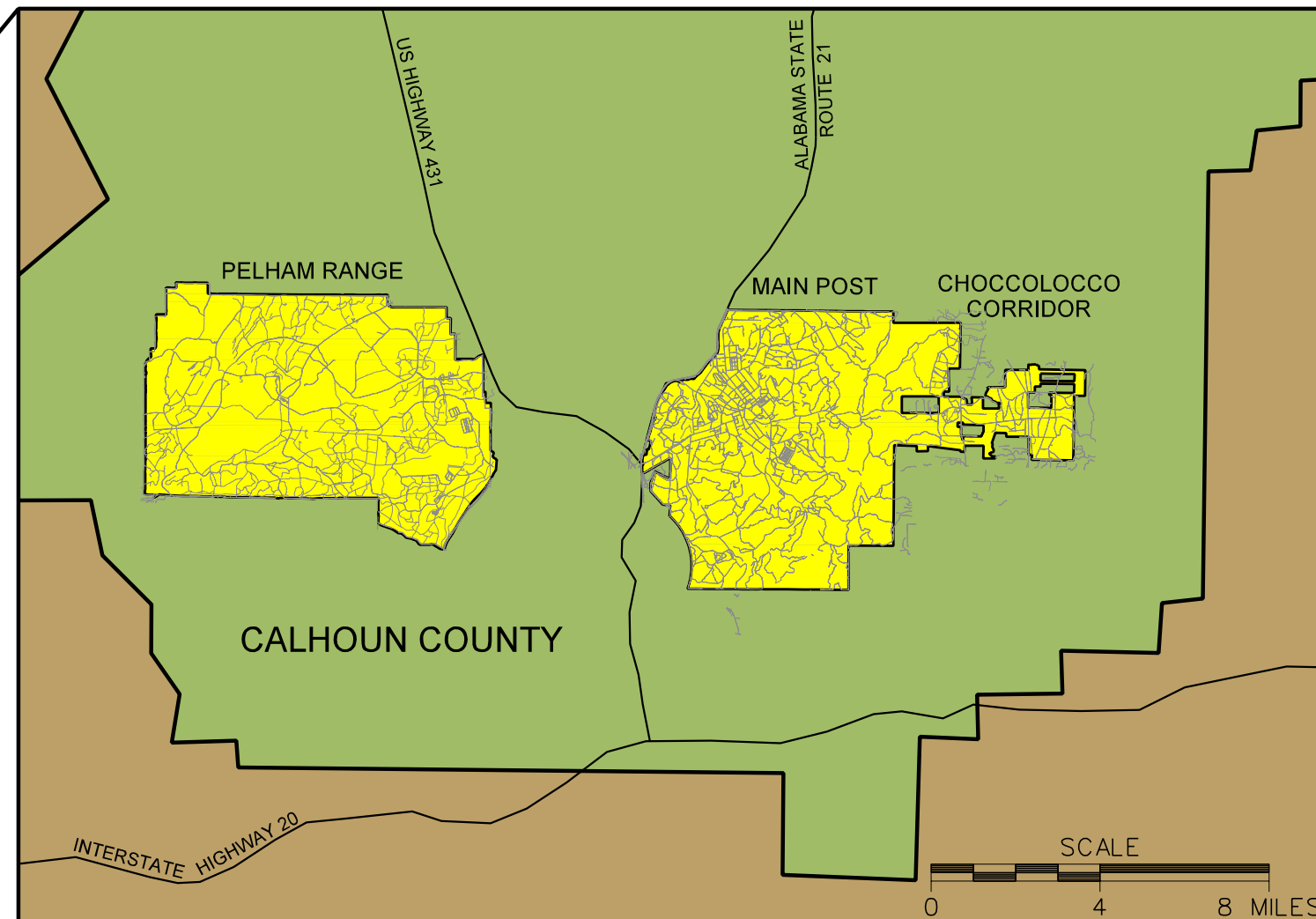


FIGURE 1-2
REGIONAL LOCATION MAP
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

permanent Women's Army Corps (WAC) training facility was established in 1955, although two previous WAC detachments had been established at the installation during the 1940s. Radiological training was conducted in the mid-1950s at Iron Mountain, Alpha Field, and Bromine Field, all located on the Main Post, as well as at Rideout Field on Pelham Range (NSA, 1993).

The mission of FTMC was changed in 1966, and it became the U.S. Army School/Training Center. An Advanced Individual Training Infantry Brigade was activated in 1966 to meet requirements for the Vietnam War. The brigade was deactivated in 1970 due to continued force reduction in Vietnam.

In 1973, the Chemical Corps School closed, along with the U.S. Army Combat Developments Command Chemical/Biological Radiological Agency. Five years later, in 1978, the WAC was disbanded and the WAC school closed.

In 1979, the Military Police (MP) School was moved to FTMC. In the same year, the U.S. Army Chemical Corps school was re-established, along with a Brigade for Basic Training. U.S. Army Forces Command units, such as D Company, 46th Engineers, were also garrisoned at the post during the 1970s and 1980s.

The mid-1980s brought additional operations to Pelham Range, which is located approximately two miles northwest of Anniston. This area was used for maneuver training and a wide range of activities from small-arms training to tank and artillery training. Pelham Range has also been used for chemical decontamination training and radiological training.

The main missions and support organizations at FTMC have been:

- U.S. Army Chemical School
- U.S. Army Military Police School
- Training Center Command
- Training Brigade
- Directorate of Contracting
- Directorate of Community Activities
- Directorate of Resource Management

- Provost Marshal Office Directorate of Community Safety
- Office of the Staff Judge Advocate
- Safety Office
- Equal Employment Opportunity Office
- Office of the Inspector General
- Internal Review and Audit Compliance
- Public Affairs Office
- Directorate of Engineering and Housing
- Directorate of Environment
- Directorate of Information Management
- Directorate of Logistics
- Directorate of Plans, Training, Mobilization, and Security and Reserve Component Support
- Women's Army Corps.

Past tenant activities included the following:

- U.S. Army Medical Department Activity
- U.S. Army Dental Activity
- U.S. Department of Defense Polygraph Institute
- Defense Finance and Accounting Services
- Defense Investigative Service
- Marine Corps Administrative Detachment
- Criminal Investigation Division
- 902nd Military Intelligence Group
- Army National Guard
- U.S. Army Reserves
- TRADOC Manpower Activity
- 722nd Explosive Ordnance Detachment
- Army Air Force Exchange Service
- Defense Commissary Agency
- Defense Reutilization and Marketing Office
- U.S. Department of Defense Security Operation Testing Support

- Fort McClellan Elementary School
- Naval Construction Training Center Detachment
- U.S. Army Corps of Engineers (Mobile District)
- U.S. Air Force Disaster Preparedness School.

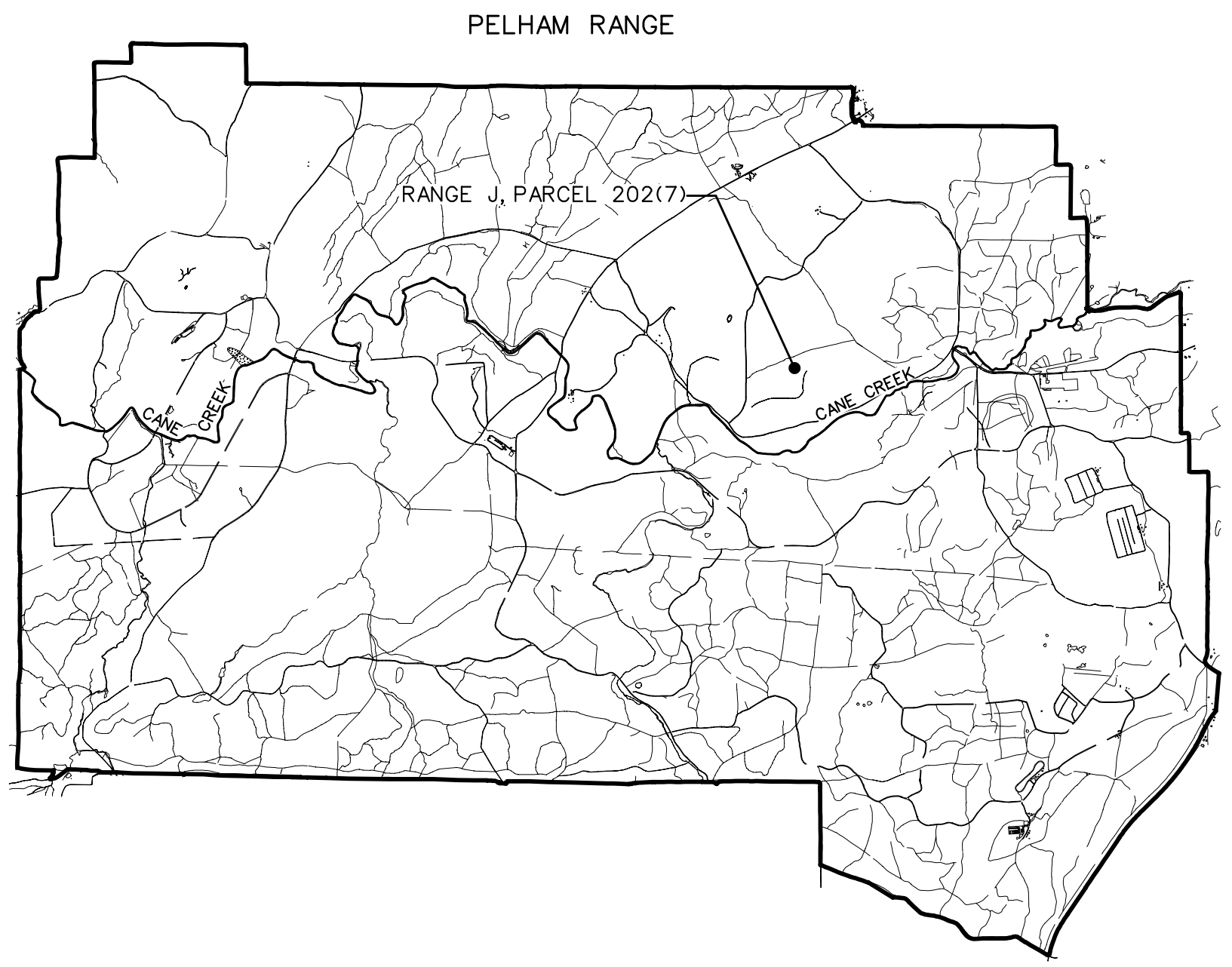
FTMC operations were deactivated and missions completed with the installation closure on September 30, 1999.

1.2.2 Range J Site Description and History

Range J is a former chemical agent training and disposal area located in the north-central portion of Pelham Range (Figure 1-3). The site was used until 1963 as a chemical agent training area as well as an agent-contaminated soil disposal area (Science Applications International Corporation [SAIC], 1995). A chain-link fence surrounds an area approximately 150 feet long by approximately 60 feet wide (0.2 acres) (Figure 1-4). An entrance gate is located in the southeastern section of the chain-link fence. A concrete monument is located inside the chain-link fence near the entrance gate. Surface topography at the site is generally flat over three-fourths of the site and slopes to the northwest in the western portion of the site near the pit. Generally, Range J is situated on a broad crest that slopes in all directions except to the northeast. The topography northeast of the site is flat.

Due to conflicting documentation reported in the environmental baseline survey (EBS) (Environmental Science and Engineering, Inc. [ESE], 1998) and in the Enhanced Preliminary Assessment Reports, the exact acreage (size) of Range J is not known. Range J is a small portion of a larger training area reportedly in use since 1954. This larger training area, approximately 60 acres, surrounds the chain-link fence. The boundaries of this larger training area are not documented (SAIC, 1995). However, SAIC was not provided with the U.S. Environmental Protection Agency (EPA) Environmental Photographic Interpretation Center (EPIC) aerial photographs. Review of aerial photographs prepared by EPIC for the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) indicates that Range J was much larger than the reported 60 acres (EPA, 1983). Based on review of aerial photographs taken in 1954, 1957, and 1961, Range J could have been approximately 170 acres. The focus of this RI is the fenced area and the area immediately surrounding the fenced area.

Drums containing soil were buried in a pit located inside the chain-link fence. The pit is located in the northwest section of the site and is approximately 10 feet wide by 40 feet long. The fenced area was reportedly used to dispose of drummed soil transported from a 110-gallon distilled mustard (HD) spill that occurred on the Main Post in 1955. The depth at which the

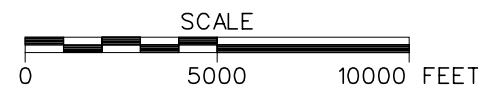


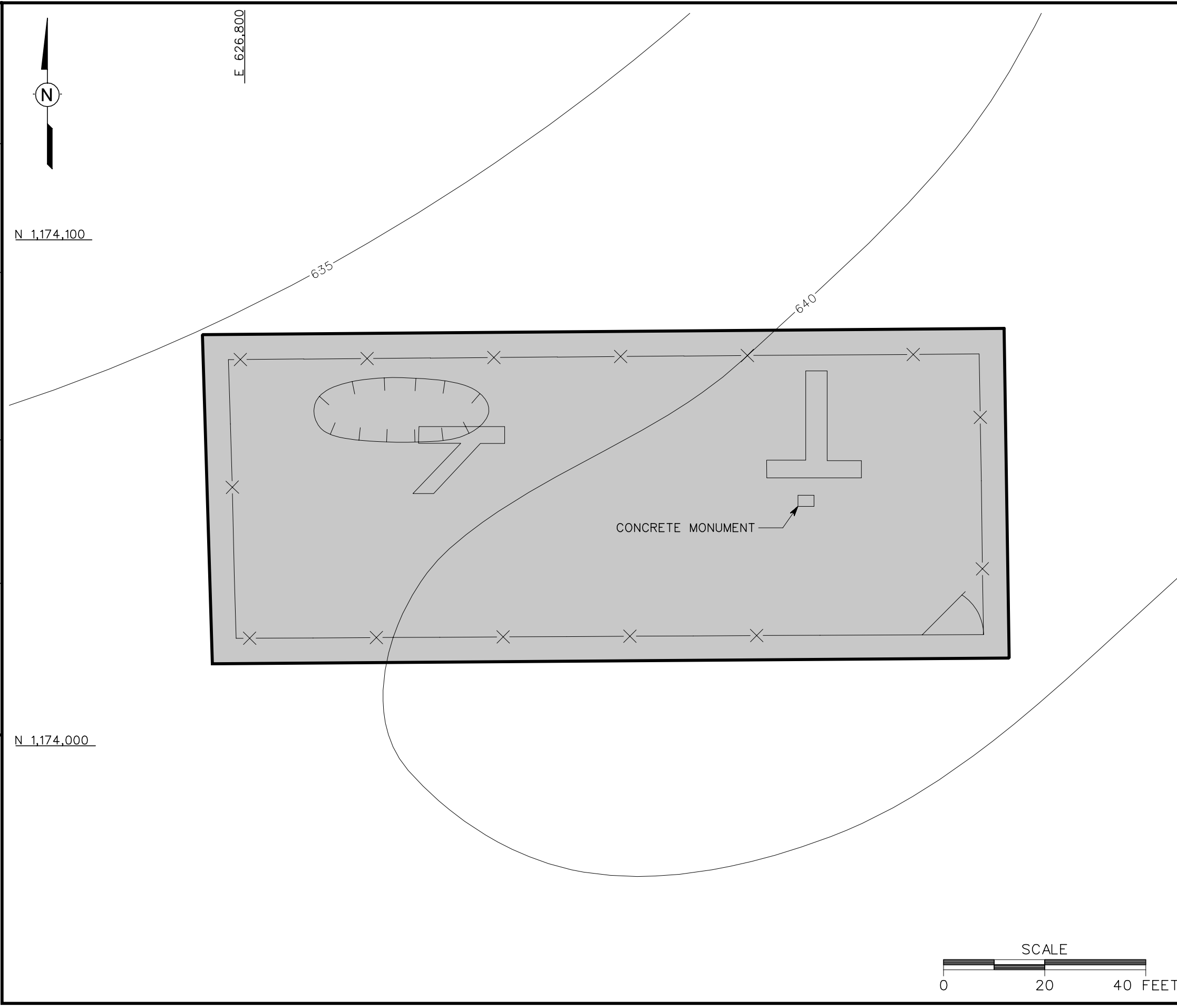
LEGEND

- PELHAM RANGE BOUNDARY
- ROADS
- SURFACE WATER / CREEKS

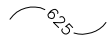
FIGURE 1-3
SITE LOCATION MAP
RANGE J - PELHAM RANGE
PARCEL 202(7)

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MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018







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
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
PARCEL BOUNDARY




FENCE



FORMER SOIL / DRUM DISPOSAL PIT



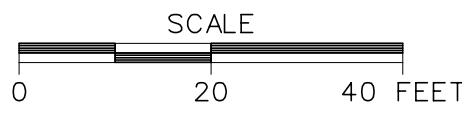
FORMER TRENCH EXCAVATION



GATE

FIGURE 1-4
SITE MAP
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018



drummed soil was buried is unknown. Under military protocol, HD-contaminated soil buried inside the chain-link fence would have been decontaminated (SAIC, 1995). During RI field activities, Shaw personnel did not observe any intact drums. Only pieces of partially buried drums were noted.

Decontamination agents were used to reduce or eliminate hazards after training exercises. Chemicals used as decontamination agents included organic or inorganic materials that contained chlorine readily available for use as an oxidizing or chlorinating agent. Inorganic materials included bleach in various forms, calcium hypochlorite, and chlorine itself. Inorganics decontaminate by oxidation and were used for large-scale decontamination. Organic compounds included the chloroamides and closely related compounds. Organic compounds decontaminate by chlorination in the absence of moisture and by oxidation in the presence of moisture. These compounds were usually dissolved in an organic solvent (e.g., carbon tetrachloride, 1,1,2,2-tetrachloroethane [PCA]). However, organic materials were expensive and were used only for small-scale operations such as destroying a blister agent on equipment (U.S. Departments of the Army and the Air Force, 1963). Chemical agents and decontamination agents reportedly used at Range J included:

- Decontamination agent (noncorrosive) (DANC)
- Decontamination Solution Number 2 (DS2)
- Supertropical bleach (STB)
- Chloroacetophenone in benzene and carbon tetrachloride (CNB)
- Chloroacetophenone in chloropicrin and chloroform (CNS)
- HD.

DANC. Prior to World War II, DANC, a well known and often used decontamination agent, may have been used or disposed of at the site in conjunction with other types of decontamination agents (e.g., DS2, STB). DANC is a 6.25-percent solution of RH-195 (1,3-dichloro-5,5-dimethylhydantoin) in 1,1,2,2-PCA (acetylene tetrachloride) and was adopted as a satisfactory HD decontamination agent in small-scale operations. It is an effective decontamination agent for arsenic-containing chemical agents, if sufficient time is allowed for it to react (U.S. Departments of the Army and the Air Force, 1963).

DS2. DS2 is a clear solution, general-purpose decontamination agent consisting of 70 percent diethylenetriamine, 28 percent solvent (ethylene glycol monomethylether), and 2 percent active agent booster (sodium hydroxide). DS2 reacts with GB (sarin) and HD to effectively reduce their hazard within 5 minutes of application. It is effective for all toxic chemical agents. DS2 was applied manually or by using a portable decontamination apparatus such as the M11 (U.S. Departments of the Army and the Air Force, 1963).

STB. STB is a decontamination agent referred to as bleach, bleaching powder, supertropical bleach, bleaching material, or chlorinated lime. STB is a white powder containing about 30 percent available chlorine (U.S. Departments of the Army and the Air Force, 1963).

CNB/CNS. CNB is a solution of chloroacetophenone (10 percent) in benzene (45 percent) and carbon tetrachloride (45 percent). CNB was adopted in 1920 for use in training and riot control as a tear agent. It remained in use until it was replaced by CNS, which is a mixture of chloroacetophenone (23 percent), chloropicrin (38.4 percent), and chloroform (38.4 percent) (U.S. Departments of the Army and the Air Force, 1963).

HD. HD is mustard (2,2'-dichlorodiethylsulfide) that has been purified by washing and vacuum distillation. HD was used as a blister agent designed to affect the eyes and lungs and blister the skin (U.S. Departments of the Army and the Air Force, 1963).

1.2.3 Previous Investigations

Previous investigations conducted at Range J are discussed in the following sections.

SAIC Site Investigation – 1992. In April 1992, SAIC conducted a site investigation (SI) to determine the presence or absence of contamination from previous military training activities. During site reconnaissance, extensively corroded drums of soil were observed in the surface burial pit. SAIC collected soil samples from three soil borings (RJ-S01, RJ-S02, and RJ-S03) installed at the site. Sample locations were chosen based on anomalies detected during reconnaissance geophysical surveys (electromagnetics and metal detection). The soil samples were screened in the field for chemical agents, namely HD, using a miniature continuous air monitoring system (MINICAMS). The soil samples were collected by the U.S. Army Technical Escort Unit (USATEU) with SAIC oversight. The USATEU determined that chemical agents were not present at the locations sampled using the MINICAMS (SAIC, 1995).

In addition to the field screening, two soil samples were collected from each of the three soil borings, at 1 foot below ground surface (bgs) and at 5 feet bgs. One soil sample (RJ-S04) was collected from a drum located in the soil/drum disposal pit area. The soil samples were analyzed for HD breakdown products, using USATHAMA Method LL03 (organosulfur compounds including 1,4-oxathiane, 1,4-dithiane, p-chlorophenylmethysulfoxide, and p-chlorophenylmethysulfone) and USATHAMA Method LW18 (thiodiglycol and chloroacetic acid). Soil samples from the three soil borings and the soil sample from the drum did not

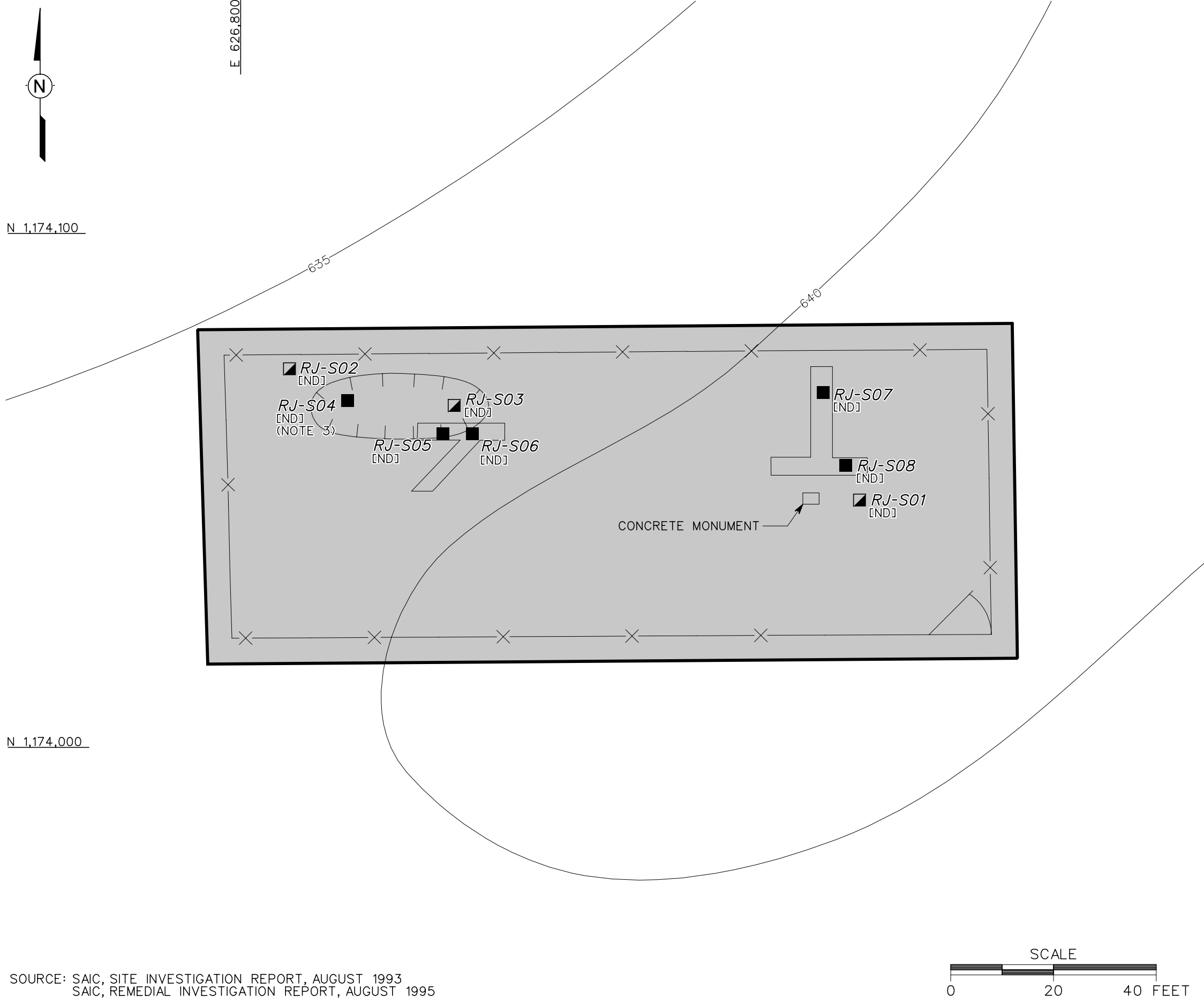
indicate the presence of HD breakdown products between a detection limit of 0.9 micrograms per liter ($\mu\text{g/L}$) and 3.9 $\mu\text{g/L}$. The locations of the soil samples collected during the SI field investigation are shown on Figure 1-5.

SAIC Remedial Investigation – 1994/1995. Based on the results of the SI, an RI was conducted in 1994 and 1995 to determine the presence, nature, and extent of potential environmental contamination resulting from chemical agent training activities and chemical waste disposal activities at the site. The investigation included:

- Field screening for chemical agents using MINICAMS.
- Excavating trenches to collect surface and subsurface soil samples for chemical analysis of chemical agents.
- Performing a surface electromagnetic (EM) geophysical survey to detect buried metallic material, potential contaminant source boundaries, and investigate the nature of potential subsurface anomalies.
- Delineating potential source boundaries and investigating the nature of potential subsurface buried materials.
- Installing groundwater monitoring wells and collecting groundwater samples.

The investigations were conducted under the direction of the USATEU, with the assistance of the U.S. Army Environmental Center. In addition, an EM geophysical survey was conducted to detect buried metallic materials at proposed soil boring locations. Several EM anomalies associated with metallic drums and debris were identified near the drum disposal pit. In addition, an anomaly was identified approximately 25 feet southwest of the concrete monument within the fenced area.

In 1995, the USATEU, with oversight by SAIC personnel, excavated two trenches at the site using a backhoe. One trench was located near the drum disposal pit, and the second trench was located north of the concrete monument. The trench locations were chosen based on anomalies detected during the EM geophysical survey, observation of extensively corroded drums within the burial pit, and the concrete monument location. Four soil samples (RJ-S05, RJ-S06, RJ-S07, and RJ-S08) were collected from the trench excavations for laboratory analysis. The soil samples were collected from the backhoe bucket during trenching operations. Samples RJ-S05 and RJ-S06 were collected from the trench located near the drum disposal pit. Samples RJ-S07 and RJ-



LEGEND

TOPOGRAPHIC CONTOURS

PARCEL BOUNDARY

FENCE

FORMER SOIL / DRUM DISPOSAL PIT

FORMER TRENCH EXCAVATION

SURFACE AND SUBSURFACE SOIL SAMPLE (SI SAMPLE APRIL, 1992)

SURFACE SOIL SAMPLE (RI SAMPLE, 1995)

NOTES

1. SURFACE SOIL SAMPLES COLLECTED AT APPROXIMATELY 1' BELOW GROUND SURFACE (bgs). SUBSURFACE SOIL SAMPLES COLLECTED AT APPROXIMATELY 5' bgs.

2. SAMPLES ANALYZED FOR HD BREAKDOWN PRODUCTS.

[END] NOT DETECTED

HD DISTILLED MUSTARD

3. SAMPLE RJ-S04 WAS COLLECTED FROM A CORRODED DRUM EXPOSED AT GROUND SURFACE.

FIGURE 1-5

SOIL SAMPLE LOCATIONS

1992 AND 1995 SAIC INVESTIGATIONS

RANGE J - PELHAM RANGE

PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

Shaw Environmental, Inc.

S08 were collected from the trench located north of the concrete monument. The four soil samples were analyzed for HD breakdown products, including thiodiglycol, organosulfur compounds, and chloroacetic acid. HD breakdown compounds were not detected in any of the soil samples. The soil sample locations are shown on Figure 1-5.

Three groundwater monitoring wells (RJ-G05, RJ-G06, and RJ-G07) were installed at Range J during the 1994 RI field investigation (Figure 1-6). Groundwater samples were collected from these wells in 1995 and were analyzed for HD breakdown products and volatile organic compounds (VOC). HD breakdown products were not detected in any of the groundwater samples. VOCs were detected in each of the samples, as summarized in Table 1-1 and as shown on Figure 1-6.

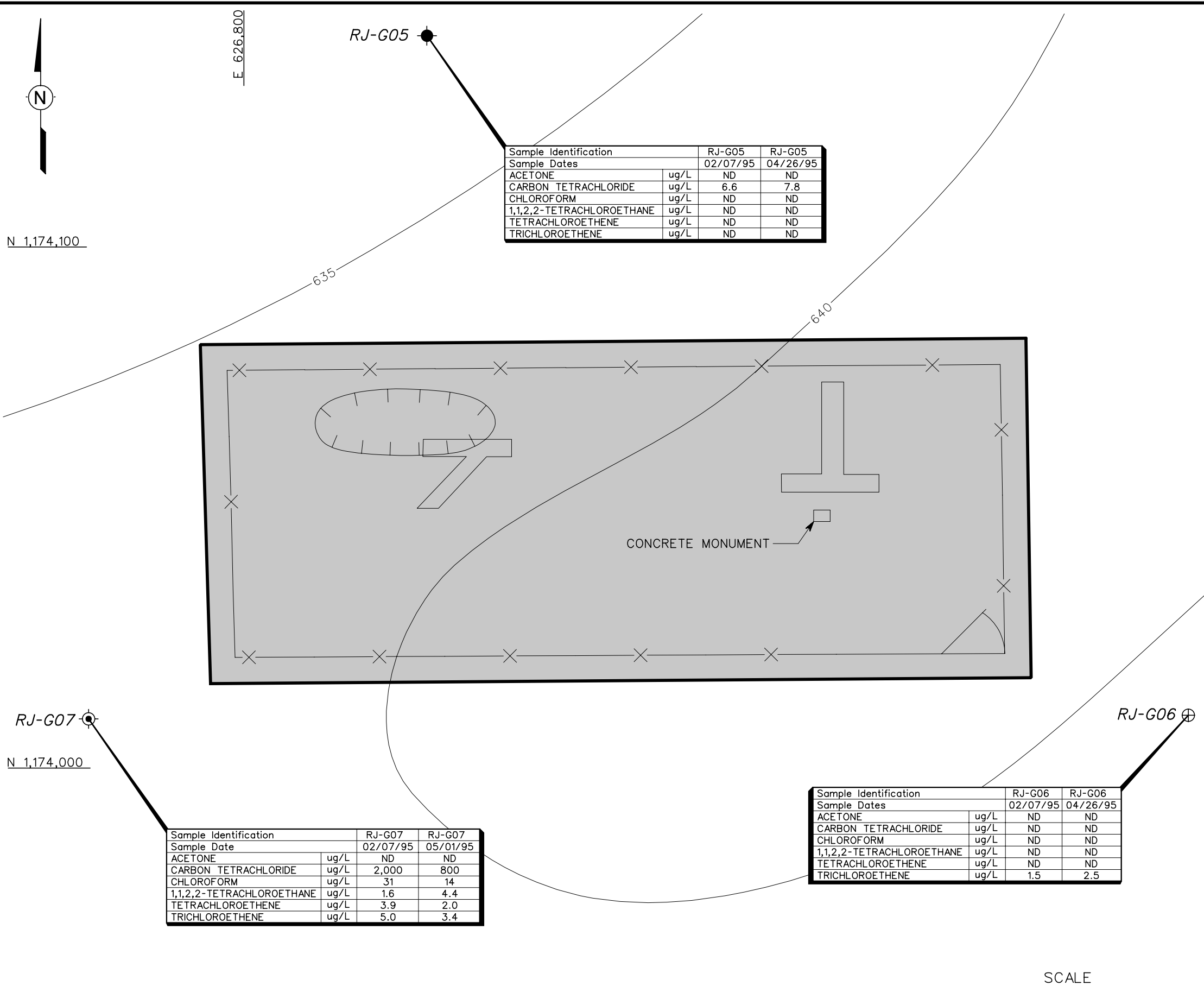
Carbon tetrachloride was detected in the groundwater samples collected from monitoring wells RJ-G05 and RJ-G07, ranging in concentration from 6.6 µg/L to 2,000 µg/L. The highest concentration (2,000 µg/L) was detected in monitoring well RJ-G07. Carbon tetrachloride was not detected in the groundwater sample collected from monitoring well RJ-G06.

Trichloroethene (TCE) was detected in groundwater samples collected from monitoring wells RJ-G06 and RJ-G07, ranging in concentration from 1.5 µg/L to 5 µg/L. The highest concentration (5 µg/L) was detected in monitoring well RJ-G07. TCE was not detected in the groundwater sample collected from monitoring well RJ-G05.

Tetrachloroethene (PCE) (3.9 µg/L), 1,1,2,2-PCA (1.6 µg/L), and chloroform (31 µg/L) were detected in the groundwater samples collected from monitoring well RJ-G07. PCE, 1,1,2,2-PCA, and chloroform were not detected in the groundwater samples collected from monitoring wells RJ-G05 and RJ-G06.

The organic solvents (i.e., carbon tetrachloride, 1,1,2,2-PCA, PCE, and TCE) detected in groundwater at Range J are most likely associated with the use of DANC, CNB, and CNS. Because the primary source of carbon tetrachloride from military activities was the usage, storage, and/or manufacture of tearing agents (CNB and CNS) or from usage as a degreaser, the contamination at Range J may be unrelated to activities that occurred within the fenced area. The carbon tetrachloride detected in groundwater may be a result of the use of tearing agents CNB and CNS used outside the fenced area (SAIC, 2000).

DWG. NO.: ...\\774645es.870
PROJ. NO.: 774645
INITIATOR: T. WINTON
DRAFT. CHK. BY:
ENGR. CHK. BY: S. MORAN
DATE LAST REV.:
DRAWN BY:
STARTING DATE: 02/20/02
DRAWN BY: D. BOWAR
08/26/2003 03:13:37 PM
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LEGEND

- TOPOGRAPHIC CONTOURS
- PARCEL BOUNDARY
- FENCE
- FORMER SOIL / DRUM DISPOSAL PIT
- FORMER TRENCH EXCAVATION
- RESIDUUM/BEDROCK MONITORING WELL
- BEDROCK MONITORING WELL
- RESIDUUM MONITORING WELL

- NOTES**
- GROUNDWATER SAMPLES ANALYZED FOR HD BREAKDOWN COMPOUNDS AND VOCs.
 - HD BREAKDOWN COMPOUNDS NOT DETECTED IN SAMPLES.
- HD DISTILLED MUSTARD
VOC VOLATILE ORGANIC COMPOUND
ug/L MICROGRAMS PER LITER

FIGURE 1-6
VOCs DETECTED IN GROUNDWATER
1995 SAIC INVESTIGATION
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

Shaw Environmental, Inc.

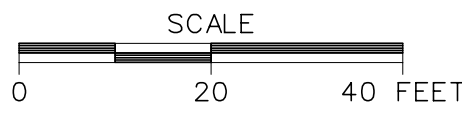


Table 1-1

**VOCs Detected in Groundwater During 1994/1995 Remedial Investigation
Fenced Area at Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

Site ID (Monitor Well Number):		RJ-G05	RJ-G05	RJ-G06	RJ-G06	RJ-G06	RJ-G07	RJ-G07
Field Sample Number:		SAIC01	SAIC02	SAIC01	SAIC02D	SAIC03	SAIC01	SAIC02
Laboratory Sample Number:		UC00468	UC00955	UC00467	UC00468	UC00954	UC00469	UC01048
Collection Date:		02/07/95	04/26/95	02/07/95	02/07/95	04/26/95	2/7/1995	5/1/1995
Depth (bgs):		61.6	57.9	65.2	65.2	61.5	66.7	62.1
QC Sample Number:		Original	Original	Original	Duplicate	Original	Original	Original
Parameters	Units							
Acetone	µg/L	ND (8)	ND (8)	ND (8)	27 D	ND (8)	ND (8)	ND (8)
Carbon Tetrachloride	µg/L	6.6	7.8	ND (1)	ND (1 D)	ND (1)	2,000	800
Chloroform	µg/L	ND (1)	ND (1)	ND (1)	ND (1D)	ND (1)	31	14
1,1,2,2-Tetrachloroethane	µg/L	ND (1.5)	ND (1.5)	ND (1.5)	ND (1.5 D)	ND (1.5)	1.6	4.4
Tetrachloroethene	µg/L	ND (1)	ND (1)	ND (1)	ND (1 D)	ND (1)	3.9	2
Trichloroethene	µg/L	ND (1)	ND (1)	1.5	1.4 D	2.5	5	3.4

Source: Science Applications International Corporation (SAIC), 2000, *Final Remedial Investigation/Baseline Risk Assessment Report, Fort McClellan, Alabama*, July.

bgs - Below ground surface.

D - Diluted sample.

µg/L - Micrograms per liter.

ND - Not detected at concentration above reporting limit listed in parenthesis.

1.3 Report Organization

This RI report is organized as follows:

- **Chapter 1.0 – Introduction.** This chapter provides site description and history information for both FTMC and Range J and summarizes previous investigations at Range J.
- **Chapter 2.0 – Study Area Investigation.** This chapter summarizes the supplemental RI field activities conducted by Shaw at Range J, including geophysical survey, environmental sampling and analysis, monitoring well installation, and slug testing.
- **Chapter 3.0 – Physical Characteristics of Study Area.** This chapter describes the physical characteristics of Range J, including demography and land reuse, meteorology, physiography, sensitive environments, soils, geology, and hydrogeology.
- **Chapter 4.0 – Nature and Extent of Contamination.** This chapter summarizes the analytical results and compares data with site-specific screening levels (SSSL), ecological screening values (ESV), and background values to determine the nature and extent of contamination and probable sources. The geophysical survey results are also presented in this chapter.
- **Chapter 5.0 – Contaminant Fate and Transport.** This chapter evaluates the chemical and physical properties of the chemicals of concern identified in Chapter 4.0. It also describes potential routes of contaminant persistence and migration.
- **Chapter 6.0 – Streamlined Human Health Risk Assessment.** This chapter presents the results of the streamlined human health risk assessment, including the conceptual site exposure model, chemicals of potential concern, risk characterization, chemicals of concern, and remedial goal options.
- **Chapter 7.0 – Screening-Level Ecological Risk Assessment.** This chapter presents the results of the screening-level ecological risk assessment, including the ecological setting, potential contaminants, site conceptual model, constituents of potential ecological concern, and uncertainty analysis.
- **Chapter 8.0 – Summary, Conclusions, and Recommendations.** This chapter summarizes the major conclusions of the RI report and provides recommendations for additional work at the site.
- **Chapter 9.0 – References.** This chapter lists the references cited in this RI report.

2.0 Study Area Investigation

This chapter summarizes site characterization activities conducted by Shaw during supplemental RI field activities at Range J, including UXO/chemical agent avoidance, geophysical survey, environmental sampling and analysis, groundwater monitoring well installation activities, and slug testing. Supplemental RI field activities were conducted in three phases from 1998 through 2001. Phase I activities, conducted in 1998 and 1999, consisted of the sampling and analysis of 24 surface soil samples, 26 subsurface soil samples, and 16 groundwater samples. Groundwater samples were collected from 13 monitoring wells installed during supplemental RI field activities and from 3 pre-existing wells installed by SAIC (IT, 1998a). During Phase II, Shaw installed 15 additional wells and collected a total of 30 groundwater samples from 14 newly installed wells (the 15th well was dry) and 16 pre-existing wells (IT, 2000b). Phase III field activities, conducted in 2001, consisted of the collection and analysis of 8 surface soil samples, 8 subsurface soil samples, and 1 sample from an unlabelled drum located southwest of the fenced area (IT, 2001a).

2.1 UXO and Chemical Agent Surveys

Because Range J falls within the “Possible Explosive Ordnance Impact Area” shown on Plate 10 of the *FTMC Archive Search Report, Maps* (USACE, 1999), the presence of UXO was possible at the site. In addition, based on the historical activities conducted at the site, the presence of chemical agents was also possible at the site. Therefore, UXO and chemical agent avoidance activities, including surface sweeps and downhole surveys of soil borings, were performed in addition to conducting utility clearances before installing soil borings.

2.1.1 Surface UXO Survey

A UXO sweep was conducted over the area of investigation to identify UXO on or near the surface that could have presented a hazard to on-site workers during field activities. Low-sensitivity magnetometers were used to locate surface and shallow-buried metal objects. UXO personnel requirements, procedures, and detailed descriptions of the geophysical equipment used are provided in the SAP.

2.1.2 Downhole UXO and Chemical Agent Survey

During the soil boring and downhole sampling activities, a downhole UXO survey was performed to determine if buried metallic objects were present. UXO monitoring, as described in the SAP, continued until undisturbed soils were encountered or the boreholes were advanced

to 12 feet bgs. Additionally, boreholes were screened continuously for chemical agents using MINICAMS.

2.2 Geophysical Survey

A geophysical survey was conducted at Range J, Parcel 202(7), to locate buried metal debris and delineate potential drum disposal areas. The geophysical survey encompassed an area of approximately 29,200 square feet (0.7 acre), as shown on Figure 2-1. A detailed discussion of the geophysical investigation, including theory of operation of the instruments, field procedures, data processing, and interpreted results of the investigation, is presented as Appendix A.

The survey was conducted using magnetic and electromagnetic (EM) techniques. An initial survey grid was established at the site to encompass the suspect disposal area.

A detailed, hand-sketched site map was drawn in the field. The map included any surface cultural features within the survey area or near its perimeter that could potentially affect the geophysical data (e.g., surface metal debris, fence, and monitoring wells).

Preliminary color contour maps of the data were analyzed and compared with the site sketch to differentiate between anomalies caused by surface and subsurface source materials. The results of the geophysical survey are summarized in Section 4.1.

2.3 Environmental Sampling

The environmental sampling performed during supplemental RI activities at Range J included the collection of surface soil samples, subsurface soil samples, groundwater samples, and a drum sample for chemical analysis. The sample locations were determined based on the results of the initial investigations conducted by SAIC, by observing site physical characteristics during a site walkover, and by reviewing historical documents pertaining to activities conducted at the site. The sample locations, media, and rationale are summarized in Table 2-1. Sampling locations are shown on Figures 2-2 and 2-3. Samples were submitted for laboratory analysis of site-related parameters listed in Section 2.5.

2.3.1 Surface Soil Sampling

Surface soil samples were collected from 32 locations during supplemental RI activities at Range J, as shown on Figures 2-2 and 2-3. At 16 locations, surface soil samples were re-collected and analyzed only for chemical warfare material (CWM) breakdown products because holding times were exceeded during analysis of the original sample. Soil sampling locations and

Table 2-1

**Sampling Locations and Rationale
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 1 of 5)

Sample Location	Sample Media	Sampling Location Rationale
RJR-202-GP01	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected in the northwest corner of the fenced area to define the nature and extent of contamination in soils at the site.
RJR-202-GP02	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected in the soil/drum disposal pit within the fenced area to define the nature and extent of contamination in soils at the site.
RJR-202-GP03	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected approximately 20 feet outside the fenced area on the north side of the site to define the nature and extent of contamination in soils at the site.
RJR-202-GP04	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected northwest of the trench excavation area to define the nature and extent of contamination in soils at the site.
RJR-202-GP05	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected in the northeast corner of the fenced area to define the nature and extent of contamination in soils at the site.
RJR-202-GP06	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected approximately 30 feet outside the fenced area on the west side of the site to define the nature and extent of contamination in soils at the site.
RJR-202-GP07	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected near the soil drum disposal pit within the fenced area to define the nature and extent of contamination in soils at the site.
RJR-202-GP08	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected in the central portion of the fenced area to define the nature and extent of contamination in soils at the site.
RJR-202-GP09	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected in the trench excavation to define the nature and extent of contamination in soils at the site.
RJR-202-GP10	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected approximately 20 feet outside the fenced area on the east side of the site to define the nature and extent of contamination in soils at the site.
RJR-202-GP11	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected near the southwest corner of the fenced area to define the nature and extent of contamination in soils at the site.
RJR-202-GP12	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected in the south-central portion of the fenced area to define the nature and extent of contamination in soils at the site.
RJR-202-GP13	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected adjacent to the trench excavation to define the nature and extent of contamination in soils at the site.

Table 2-1

**Sampling Locations and Rationale
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 2 of 5)

Sample Location	Sample Media	Sampling Location Rationale
RJR-202-GP14	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected south of the concrete monument, inside the fenced area to define the nature and extent of contamination in soils at the site.
RJR-202-GP15	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected inside the fenced area in the southeastern corner of the site of the site near the entrance gate to define the nature and extent of contamination in soils at the site.
RJR-202-GP16	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected in approximately 40 feet outside the fenced area near drums on the south side of the site to define the nature and extent of contamination in soils at the site.
RJR-202-GP17	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected in the western portion of the fenced area to define the extent of contamination in soils.
RJR-202-GP18	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected just south of the fenced area, north of the drums located south-southwest of the fenced area to better define the extent of contamination in soils around the drums.
RJR-202-GP19	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected south of the fenced area in the vicinity of the drums located south-southwest of the fenced area to better define the extent of contamination in soils around the drums.
RJR-202-GP20	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected south of the fenced area adjacent to the drums located south-southwest of the fenced area to better define the extent of contamination in soils around the drums.
RJR-202-GP21	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected southwest of the fenced area in the vicinity of the drums located south-southwest of the fenced area to better define the extent of contamination in soils around the drums.
RJR-202-GP22	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected southwest of the fenced area in the vicinity of the drums located south-southwest of the fenced area to better define the extent of contamination in soils around the drums.
RJR-202-GP23	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected southwest of the fenced area to better define the extent of contamination in soils around the drums.
RJR-202-GP24	Surface Soil Subsurface Soil	Surface and subsurface soil samples were collected approximately 60 feet northwest of the drums to better define the extent of contamination in soils around the drums.
RJR-202-MW01	Groundwater	Groundwater samples were collected from existing monitoring well (RJ-G05) to determine the nature and extent of groundwater contamination. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW02	Groundwater	Groundwater samples were collected from existing monitoring well (RJ-G06) to determine the nature and extent of groundwater contamination. Two rounds of groundwater samples were collected from this monitoring well.

Table 2-1

**Sampling Locations and Rationale
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 3 of 5)

Sample Location	Sample Media	Sampling Location Rationale
RJR-202-MW03	Groundwater	Groundwater samples were collected from existing monitoring well (RJ-G07) to determine the nature and extent of groundwater contamination. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW04	Surface Soil Subsurface Soil Groundwater	Surface soil, subsurface soil, and groundwater samples were collected approximately 250 feet east of existing monitoring well RJ-G06 to define the nature and extent of contamination in soils and groundwater. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW05	Surface Soil Subsurface Soil Groundwater	Surface soil, subsurface soil, and groundwater samples were collected approximately 250 feet southeast of existing monitoring well RJ-G07 to define the nature and extent of contamination in soils and groundwater. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW06	Surface Soil Subsurface Soil Groundwater	Surface soil, subsurface soil, and groundwater samples were collected approximately 300 feet southwest of existing monitoring well RJ-G07 to define the nature and extent of contamination in soils and groundwater. Two subsurface soil samples were collected at this location because of elevated PID readings. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW07	Surface Soil Subsurface Soil Groundwater	Surface soil, subsurface soil, and groundwater samples were collected approximately 250 feet northwest of the site to define the nature and extent of contamination in soils and groundwater. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW08	Surface Soil Subsurface Soil Groundwater	Surface soil, subsurface soil, and groundwater samples were collected approximately 250 feet north of the site to define the nature and extent of contamination in soils and groundwater. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW09	Surface Soil Subsurface Soil Groundwater	Surface soil, subsurface soil, and groundwater samples were collected near existing bedrock monitoring well RJ-G05 to define the nature and extent of contamination in soils and groundwater. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW10	Surface Soil Subsurface Soil Groundwater	Surface soil, subsurface soil, and groundwater samples were collected near existing monitoring well RJ-G07 to delineate the vertical extent of groundwater contamination within the suspected source area. Two subsurface soil samples were collected at this location because of elevated PID readings. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW11	Groundwater	Groundwater samples were collected from a bedrock monitoring well installed adjacent to existing well RJ-G07, near the suspected source area southwest of the fenced area, to delineate the vertical extent of groundwater contamination. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW12	Surface Soil Subsurface Soil Groundwater	Surface soil, subsurface soil, and groundwater samples were collected adjacent to existing monitoring well RJ-G06, southeast of the site to define the nature and extent of contamination in soils and groundwater. Two rounds of groundwater samples were collected from this monitoring well.

Table 2-1

**Sampling Locations and Rationale
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 4 of 5)

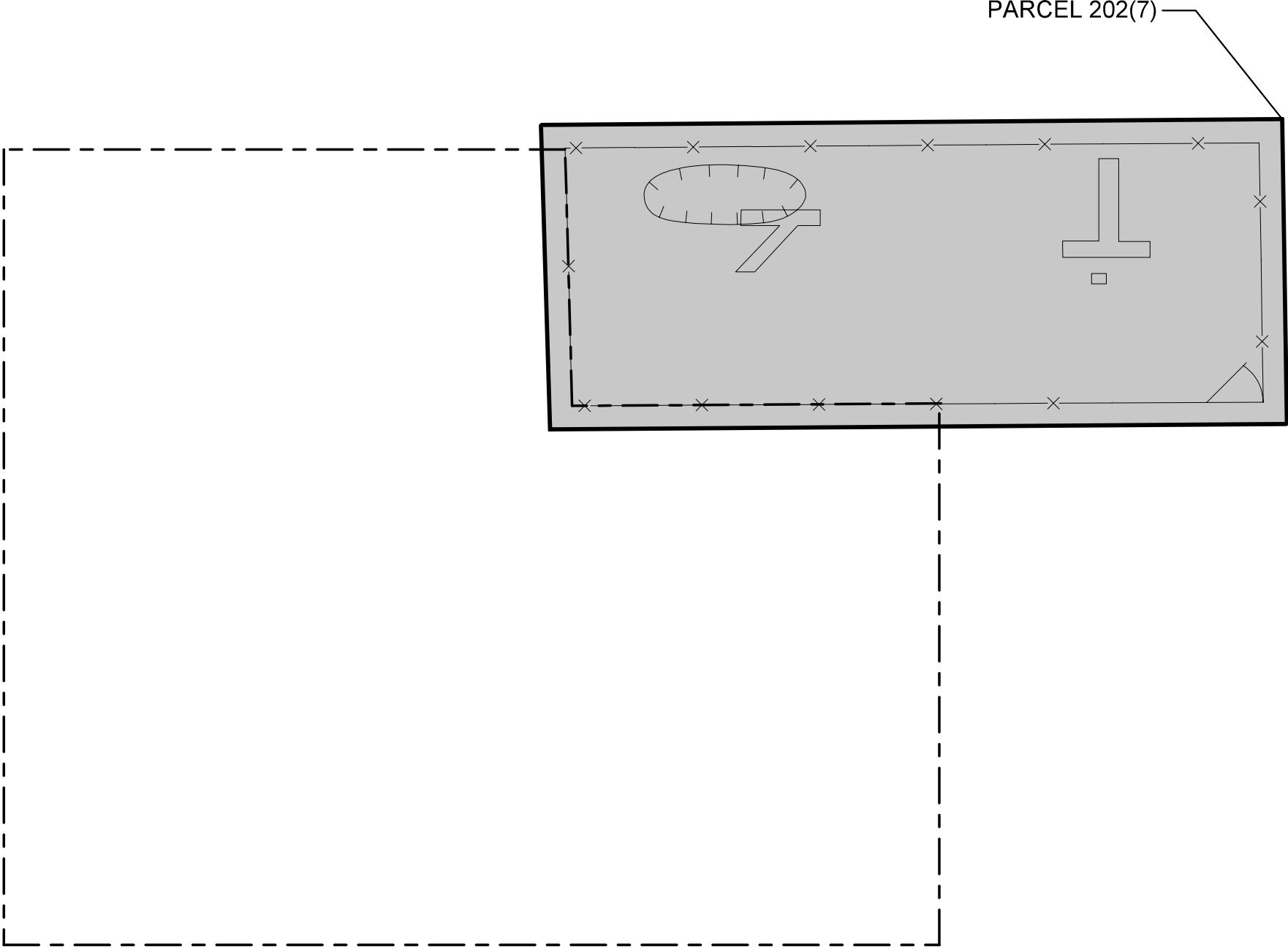
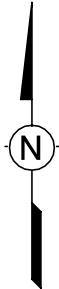
Sample Location	Sample Media	Sampling Location Rationale
RJR-202-MW13	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 200 feet south (upgradient) of the site, next to residuum monitoring well RJR-202-MW05 to delineate the vertical extent of groundwater contamination. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW14	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 250 feet northwest (downgradient) of the site, next to residuum monitoring well RJR-202-MW07 to delineate the vertical extent of groundwater contamination. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW15	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 350 feet southwest of the site, next to residuum monitoring well RJR-202-MW06 to delineate the vertical extent of groundwater contamination. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW16	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 300 feet east-southeast of the site, near residuum monitoring well RJR-202-MW04 to delineate the vertical extent of groundwater contamination. Two rounds of groundwater samples were collected from this monitoring well.
RJR-202-MW18	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 200 feet north of the fenced area, near residuum monitoring well RJR-202-MW17 to define the nature and extent of contamination in groundwater.
RJR-202-MW20	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 100 feet northwest of the fenced area to define the nature and extent of contamination in groundwater.
RJR-202-MW22	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 125 feet west of the fenced area to define the nature and extent of contamination in groundwater.
RJR-202-MW25	Groundwater	A groundwater sample was collected from a residuum monitoring well installed approximately 150 feet south of the fenced area to define the nature and extent of contamination in groundwater.
RJR-202-MW26	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 150 feet south of the fenced area, near residuum monitoring well RJR-202-MW25 to define the nature and extent of contamination in groundwater.
RJR-202-MW27	Groundwater	A groundwater sample was collected from a residuum monitoring well installed approximately 175 feet southwest of the fenced area to define the nature and extent of contamination in groundwater.
RJR-202-MW28	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 175 feet southwest of the fenced area, near residuum monitoring well RJR-202-MW27 to define the nature and extent of contamination in groundwater.

Table 2-1

**Sampling Locations and Rationale
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 5 of 5)

Sample Location	Sample Media	Sampling Location Rationale
RJR-202-MW30	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 150 feet southwest of the fenced area to define the nature and extent of contamination in groundwater.
RJR-202-MW31	Groundwater	A groundwater sample was collected from a residuum monitoring well installed approximately 275 feet west-southwest of the fenced area to define the nature and extent of contamination in groundwater.
RJR-202-MW32	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 275 feet west-southwest of the fenced area, near residuum monitoring well RJR-202-MW31 to define the nature and extent of contamination in groundwater.
RJR-202-MW33	Groundwater	A groundwater sample was collected from a residuum monitoring well installed approximately 200 feet west of the fenced area to define the nature and extent of contamination in groundwater.
RJR-202-MW34	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 200 feet west of the fenced area, next to residuum monitoring well RJR-202-MW33 to define the nature and extent of contamination in groundwater.
RJR-202-MW35	Groundwater	A groundwater sample was collected from a residuum monitoring well installed approximately 175 feet northwest of the fenced area to define the nature and extent of contamination in groundwater.
RJR-202-MW36	Groundwater	A groundwater sample was collected from a bedrock monitoring well installed approximately 175 feet northwest of the fenced area, next to residuum monitoring well RJR-202-MW35 to define the nature and extent of contamination in groundwater.
RJR-202-DR01	Drum Contents	A liquid sample was collected from an intact, unlabelled drum located south-southwest of the fenced area to determine nature of the drum's contents.



LEGEND

- PARCEL BOUNDARY
- GEOPHYSICAL SURVEY BOUNDARY
- FENCE
- FORMER SOIL / DRUM DISPOSAL PIT
- FORMER TRENCH EXCAVATION
- GATE

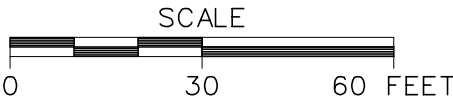
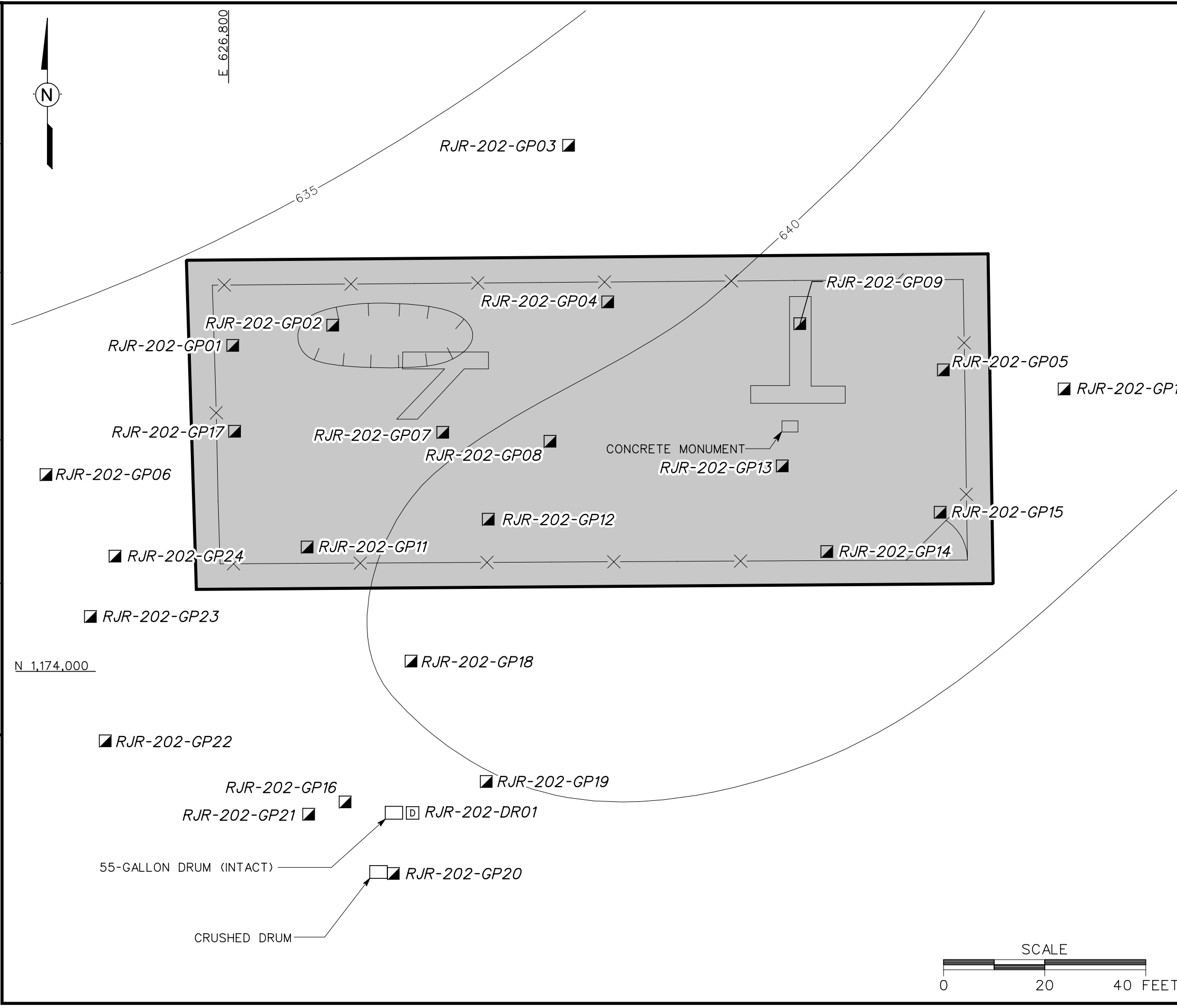


FIGURE 2-1
EXTENT OF GEOPHYSICAL
SURVEY AREA
RANGE J - PELHAM RANGE
PARCEL 202(7)
U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

dbomar
c:\cadd\design\774645es.871
08/26/2003 03:28 PM
STARTING DATE: 02/20/02
DRAWN BY: D. BOMAR
DATE LAST REV.:
DRAFT, CHECK, BY:
ENGR. CHECK, BY: S. MORAN
INITIATOR: T. WINTON
PROJ. MGR.: J. YACOB
DWG. NO.: ... \774645es.871
PROJ. NO.: 774645



LEGEND

- TOPOGRAPHIC CONTOURS
- PARCEL BOUNDARY
- FENCE
- FORMER SOIL / DRUM DISPOSAL PIT
- FORMER TRENCH EXCAVATION
- SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION
- DRUM SAMPLE LOCATION

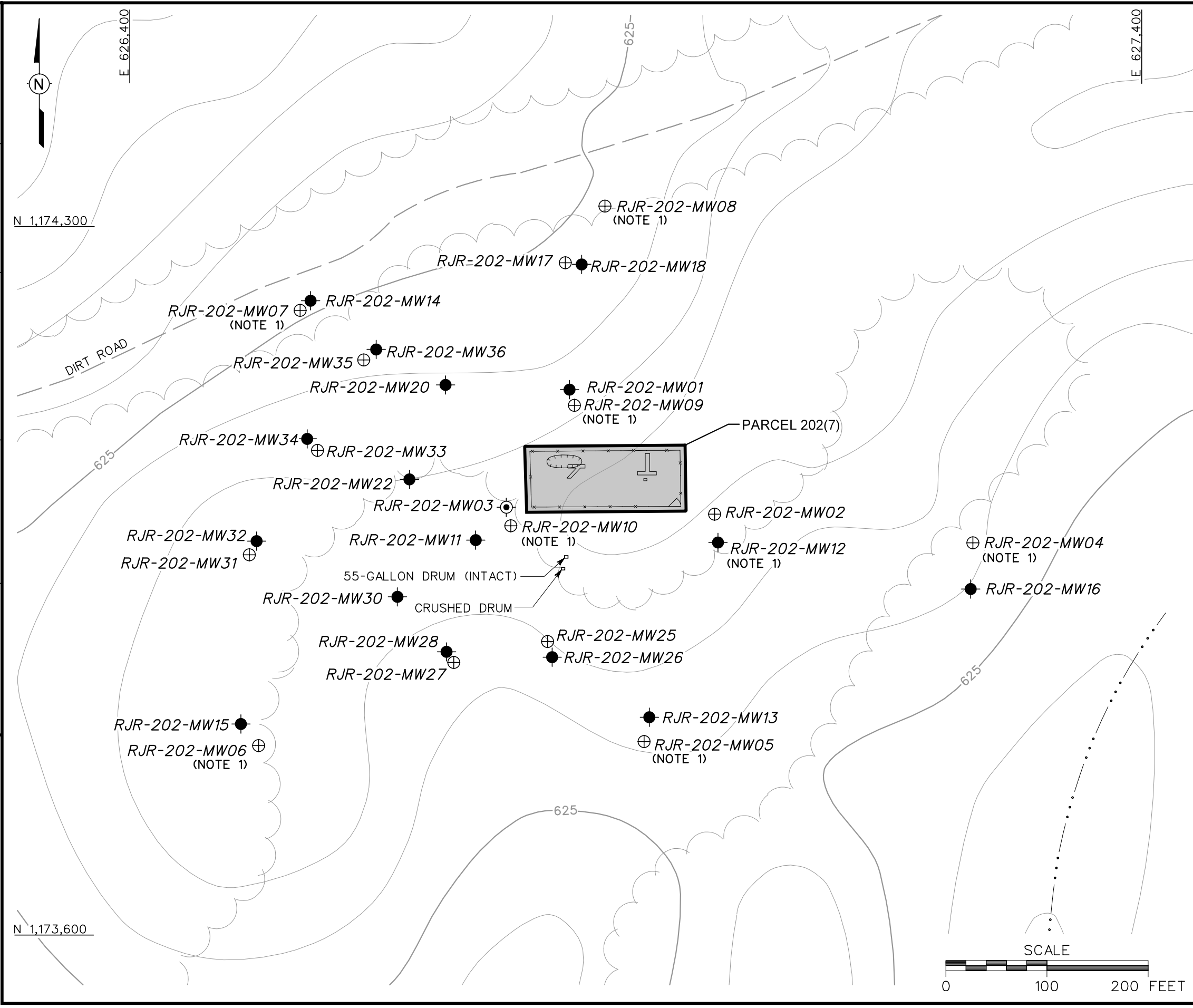
NOTES

1. SEE FIGURE 2-3 FOR ADDITIONAL SOIL SAMPLE LOCATIONS NOT SHOWN ON THIS FIGURE.

FIGURE 2-2
SOIL AND DRUM SAMPLE LOCATIONS
RANGE J - PELHAM RANGE
PARCEL 202(7)

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dbomar

DATE LAST REV.:	INITIATOR: T. WINTON	DWG. NO.: ... \774645es.872
DRAWN BY: D. BOWAR	ENGR. CHK. BY: S. MORAN	PROJ. NO.: 774645
STARTING DATE: 02/20/02	DRAFT. CHK. BY:	PROJ. MGR.: J. YACOB



- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION

NOTE:

1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.

FIGURE 2-3
MONITORING WELL LOCATIONS
RANGE J - PELHAM RANGE
PARCEL 202(7)

rationale are presented in Table 2-1. Soil sample designations and analytical parameters are listed in Table 2-2. Soil sampling locations were determined in the field by the on-site geologist based on UXO/chemical agent avoidance activities, sampling rationale, presence of surface structures, and site topography.

Sample Collection. Surface soil samples were collected from the uppermost foot of soil using either a direct-push technology (DPT) sampling system or a stainless-steel hand auger following the methodology specified in the SAP. Surface soil samples were collected by first removing surface debris (e.g., rocks, vegetation) from the immediate sample area. The soil was then collected with the sampling device and screened with a photoionization detector (PID) in accordance with procedures in the SAP. Samples for VOC analysis were collected directly from the sampler using three EnCore[®] samplers. The remaining portion of the soil was transferred to a clean stainless-steel bowl, homogenized, and placed in the appropriate sample containers. Sample collection logs are included in Appendix B. The samples were analyzed for the parameters listed in Table 2-2 using methods outlined in Section 2.5.

2.3.2 Subsurface Soil Sampling

Thirty-four subsurface soil samples were collected from 32 soil borings at Range J, as shown on Figures 2-2 and 2-3. One subsurface soil sample was collected from each soil boring, except at two locations (RJR-202-MW06 and RJR-202-MW10), where two subsurface soil samples were collected from each boring because of elevated PID readings. At 16 locations, subsurface soil samples were re-collected and analyzed only for CWM breakdown products because holding times were exceeded during analysis of the original sample. Subsurface soil sampling locations and rationale are presented in Table 2-1. Subsurface soil sample designations, depths, and analytical parameters are listed in Table 2-2. Soil boring sampling locations were determined in the field by the on-site geologist based on UXO/chemical agent avoidance activities, sampling rationale, presence of surface structures, and site topography.

Sample Collection. Subsurface soil samples were collected from soil borings at depths greater than 1 foot bgs in the unsaturated zone. The soil borings were advanced and soil samples collected using the DPT sampling procedures specified in the SAP. Sample collection logs are included in Appendix B. The samples were analyzed for the parameters listed in Table 2-2 using methods outlined in Section 2.5.

Subsurface soil samples were collected continuously to 12 feet bgs or until DPT sampler refusal was encountered. Samples were field-screened using a PID in accordance with procedures

Table 2-2

Soil Sample Designations and Analytical Parameters
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 1 of 3)

Sample Location	Sample Designation	Sample Depth (ft. bgs)	QA/QC Samples			Analytical Parameters
			Field Duplicates	Field Splits	MS/MSD	
RJR-202-GP01	RJR-202-GP01-SS-JB0001-REG	0-2				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP01-SS-JB0001R-REG*	0-2				
	RJR-202-GP01-DS-JB0002-REG	10-12				
	RJR-202-GP01-DS-JB0002R-REG*	10-12				
RJR-202-GP02	RJR-202-GP02-SS-JB0003-REG	0-2			RJR-202-GP02-SS-JB0003-MS/MSD	TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP02-SS-JB0003R-REG*	0-2				
	RJR-202-GP02-DS-JB0004-REG	10-12				
	RJR-202-GP02-DS-JB0004R-REG*	10-12				
RJR-202-GP03	RJR-202-GP03-SS-JB0005-REG	0-1	RJR-202-GP03-SS-JB0006-FD	RJR-202-GP03-SS-JB0007-FS		TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP03-SS-JB0005R-REG*	0-1				
	RJR-202-GP03-DS-JB0008-REG	10-12				
	RJR-202-GP03-DS-JB0008R-REG*	10-12				
RJR-202-GP04	RJR-202-GP04-SS-JB0009-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP04-SS-JB0009R-REG*	0-1				
	RJR-202-GP04-DS-JB0010-REG	10-12				
	RJR-202-GP04-DS-JB0010R-REG*	10-12				
RJR-202-GP05	RJR-202-GP05-SS-JB0011-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP05-SS-JB0011R-REG*	0-1				
	RJR-202-GP05-DS-JB0012-REG	1-2				
	RJR-202-GP05-DS-JB0012R-REG*	1-2				
RJR-202-GP06	RJR-202-GP06-SS-JB0013-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP06-SS-JB0013R-REG*	0-1				
	RJR-202-GP06-DS-JB0014-REG	10-12				
	RJR-202-GP06-DS-JB0014R-REG*	10-12				
RJR-202-GP07	RJR-202-GP07-SS-JB0015-REG	0-1	RJR-202-GP07-DS-JB0017-FD	RJR-202-GP07-DS-JB0018-FS		TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP07-SS-JB0015R-REG*	0-1				
	RJR-202-GP07-DS-JB0016-REG	10-12				
	RJR-202-GP07-DS-JB0016R-REG*	10-12				
RJR-202-GP08	RJR-202-GP08-SS-JB0019-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP08-SS-JB0019R-REG*	0-1				
	RJR-202-GP08-DS-JB0020-REG	1-2				
	RJR-202-GP08-DS-JB0020R-REG*	1-2				
RJR-202-GP09	RJR-202-GP09-SS-JB0021-REG	0-1	RJR-202-GP09-SS-JB0026R-FD			TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP09-SS-JB0021R-REG*	0-1				
	RJR-202-GP09-DS-JB0022-REG	2-4				
	RJR-202-GP09-DS-JB0022R-REG*	2-4				
RJR-202-GP10	RJR-202-GP10-SS-JB0023-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP10-SS-JB0023R-REG*	0-1				
	RJR-202-GP10-DS-JB0024-REG	10-12				
	RJR-202-GP10-DS-JB0024R-REG*	10-12				

Table 2-2

Soil Sample Designations and Analytical Parameters
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 2 of 3)

Sample Location	Sample Designation	Sample Depth (ft. bgs)	QA/QC Samples			Analytical Parameters
			Field Duplicates	Field Splits	MS/MSD	
RJR-202-GP11	RJR-202-GP11-SS-JB0025-REG	0-1	RJR-202-GP11-SS-JB0026-FD	RJR-202-GP11-SS-JB0027-FS		TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP11-SS-JB0025R-REG*	0-1				
	RJR-202-GP11-DS-JB0028-REG	8-10				
	RJR-202-GP11-DS-JB0028R-REG*	8-10				
RJR-202-GP12	RJR-202-GP12-SS-JB0029-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP12-SS-JB0029R-REG*	0-1				
	RJR-202-GP12-DS-JB0030-REG	10-12				
	RJR-202-GP12-DS-JB0030R-REG*	10-12				
RJR-202-GP13	RJR-202-GP13-SS-JB0031-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP13-SS-JB0031R-REG*	0-1				
	RJR-202-GP13-DS-JB0032-REG	10-12				
	RJR-202-GP13-DS-JB0032R-REG*	10-12				
RJR-202-GP14	RJR-202-GP14-SS-JB0033-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP14-SS-JB0033R-REG*	0-1				
	RJR-202-GP14-DS-JB0034-REG	10-12				
	RJR-202-GP14-DS-JB0034R-REG*	10-12				
RJR-202-GP15	RJR-202-GP15-SS-JB0035-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP15-SS-JB0035R-REG*	0-1				
	RJR-202-GP15-DS-JB0036-REG	10-12				
	RJR-202-GP15-DS-JB0036R-REG*	10-12				
RJR-202-GP16	RJR-202-GP16-SS-JB0037-REG	0-1			RJR-202-GP16-SS-JB0037-MS/MSD	TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-GP16-SS-JB0037R-REG*	0-1				
	RJR-202-GP16-DS-JB0038-REG	10-12				
	RJR-202-GP16-DS-JB0038R-REG*	10-12				
RJR-202-GP17	RJR-202-GP17-SS-JBB0001-REG	0-1				TCL VOCs and TAL Metals
	RJR-202-GP17-DS-JBB0002-REG	11-12				
RJR-202-GP18	RJR-202-GP18-SS-JBB0003-REG	0-1			RJR-202-GP18-SS-JBB0003-MS/MSD RJR-202-GP18-DS-JBB0004-MS/MSD	TCL VOCs and TAL Metals
	RJR-202-GP18-DS-JBB0004-REG	11-12				
RJR-202-GP19	RJR-202-GP19-SS-JBB0005-REG	0-1				TCL VOCs and TAL Metals
	RJR-202-GP19-DS-JBB0006-REG	11-12				
RJR-202-GP20	RJR-202-GP20-SS-JBB0007-REG	0-1				TCL VOCs and TAL Metals
	RJR-202-GP20-DS-JBB0008-REG	11-12				
RJR-202-GP21	RJR-202-GP21-SS-JBB0009-REG	0-1				TCL VOCs and TAL Metals
	RJR-202-GP21-DS-JBB0010-REG	11-12				
RJR-202-GP22	RJR-202-GP22-SS-JBB0011-REG	0-1				TCL VOCs and TAL Metals
	RJR-202-GP22-DS-JBB0012-REG	11-12				
RJR-202-GP23	RJR-202-GP23-SS-JBB0013-REG	0-1				TCL VOCs and TAL Metals
	RJR-202-GP23-DS-JBB0014-REG	11-12				

Table 2-2

Soil Sample Designations and Analytical Parameters
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 3 of 3)

Sample Location	Sample Designation	Sample Depth (ft. bgs)	QA/QC Samples			Analytical Parameters
			Field Duplicates	Field Splits	MS/MSD	
RJR-202-GP24	RJR-202-GP24-SS-JBB0015-REG	0-1				TCL VOCs and TAL Metals
	RJR-202-GP24-DS-JBB0016-REG	11-12				
RJR-202-MW04	RJR-202-MW04-SS-JB0050-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW04-DS-JB0049-REG	2-4				
RJR-202-MW05	RJR-202-MW05-SS-JB0052-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW05-DS-JB0051-REG	6-8				
RJR-202-MW06	RJR-202-MW06-SS-JB0054-REG	0-1			RJR-202-MW06-DS-JB0053-MS/MSD	TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW06-DS-JB0053-REG	8-10				
	RJR-202-MW06-DS-JB0067-REG	54-56				
RJR-202-MW07	RJR-202-MW07-SS-JB0056-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW07-DS-JB0055-REG	10-12				
RJR-202-MW08	RJR-202-MW08-SS-JB0059-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW08-DS-JB0058-REG	1-3				
RJR-202-MW09	RJR-202-MW09-SS-JB0061-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW09-DS-JB0060-REG	10-12				
RJR-202-MW10	RJR-202-MW10-SS-JB0063-REG	0-1				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW10-DS-JB0062-REG	10-12				
	RJR-202-MW10-DS-JB0068-REG	19-21				
RJR-202-MW12	RJR-202-MW12-SS-JB0065-REG	0-1	RJR-202-MW12-SS-JB0066-FD			TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW12-DS-JB0064-REG	10-12				

* Sample recollected and analyzed for CWM breakdown products only because of holding time exceedances.

CWM - Chemical warfare material.

FD - Field duplicate.

FS - Field split.

ft. bgs - Feet below ground surface.

MS/MSD - Matrix spike/matrix spike duplicate.

QA/QC - Quality assurance/quality control.

REG - Regular field sample.

SVOC - Semivolatile organic compound.

TAL - Target analyte list.

TCL - Target compound list.

VOC - Volatile organic compound.

outlined in the SAP to measure volatile organic vapors. The soil sample displaying the highest reading was selected and sent to the laboratory for analysis; however, at those locations where PID readings were below background, the deepest soil sample interval above the saturated zone was submitted for analysis. Samples for VOC analysis were collected directly from the sampler with three EnCore samplers. The remaining portion of the soil was transferred to a clean stainless-steel bowl, homogenized, and placed in the appropriate sample containers. The on-site geologist constructed a detailed boring log for each soil boring (Appendix C).

At the completion of soil sampling, boreholes were abandoned with bentonite pellets and hydrated with potable water, following borehole abandonment procedures summarized in the SAP.

2.3.3 Drum Sampling

One liquid sample was collected from an intact, unlabelled 55-gallon drum located south-southwest of the fenced area (Figure 2-2). The sample of the drum contents was collected using a drum thief sampler and placed into the appropriate sample containers. The sample collection log is included in Appendix B. The sample was analyzed for the parameters listed in Table 2-3 using methods outlined in Section 2.5.

2.3.4 Monitoring Well Installation

Shaw installed 28 permanent monitoring wells, including 13 residuum wells and 15 bedrock wells, at Range J to provide site-specific geological and hydrogeological data and to collect groundwater samples for laboratory analysis. The well locations are shown on Figure 2-3. Table 2-4 summarizes construction details of the monitoring wells installed at the site. The well construction logs are included in Appendix C. Shaw contracted Miller Drilling, Inc. to provide drilling services for installation of the wells. The monitoring wells were installed following procedures outlined in the SAP.

2.3.4.1 Residuum Monitoring Wells

The borehole at each residuum monitoring well location was advanced with a 6.25-inch inside diameter (ID) hollow-stem auger from ground surface to the top of bedrock. A 2-foot-long, 2-inch ID carbon steel split-spoon sampler was driven at 5-foot intervals to collect residuum for observing and describing lithology. Where split-spoon refusal was encountered, the auger was advanced until the first water-bearing zone was encountered. The on-site geologist logging the auger boreholes continued the lithological log for each borehole from the depth of split-spoon sampler refusal to the bottom of the auger borehole by logging the auger drill cuttings. The drill

Table 2-3

**Drum Sample Designation and Analytical Parameters
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

Sample Location	Sample Designation	QA/QC Samples			Analytical Parameters
		Field Duplicates	Field Splits	MS/MSD	
RJR-202-DR01	RJR-202-DR01-DR-JBB4001-REG	RJR-202-DR01-DR-JBB4002-FD			TCL VOCs, TCL SVOCs, and TAL Metals

FD - Field duplicate.

MS/MSD - Matrix spike/matrix spike duplicate.

QA/QC - Quality assurance/quality control.

REG - Regular field sample.

SVOC - Semivolatile organic compound.

TAL - Target analyte list.

TCL - Target compound list.

VOC - Volatile organic compound.

Table 2-4

**Monitoring Well Construction Summary
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

Well Location	Northing	Easting	Ground Elevation (ft amsl)	TOC Elevation (ft amsl)	Well Depth (ft bgs)	Screen Length (ft)	Screen Interval (ft bgs)	Well Material
RJR-202-MW04	1173985.72	627234.81	629.59	630.56	93	10	80 - 90	4" ID Sch. 80 PVC
RJR-202-MW05	1173789.38	626909.94	631.10	633.12	86	10	73 - 83	4" ID Sch. 80 PVC
RJR-202-MW06	1173785.38	626529.19	638.27	640.68	101	10	88 - 98	4" ID Sch. 80 PVC
RJR-202-MW07	1174215.37	626570.13	625.21	627.57	64	10	54 - 64	4" ID Sch. 80 PVC
RJR-202-MW08	1174318.34	626871.34	629.60	632.15	65.4	10	55.4 - 65.4	4" ID Sch. 80 PVC
RJR-202-MW09	1174121.49	626841.13	635.70	637.80	85	10	72 - 82	4" ID Sch. 80 PVC
RJR-202-MW10	1174002.54	626778.27	639.04	641.05	93	10	80 - 90	4" ID Sch. 80 PVC
RJR-202-MW11	1173988.39	626743.50	637.66	639.76	130	15	110 - 125	4" ID Sch. 80 PVC
RJR-202-MW12	1173986.15	626982.96	637.35	638.82	133.2	15	113.2 - 128.2	4" ID Sch. 80 PVC
RJR-202-MW13	1173813.39	626915.17	632.05	633.92	127	10	116 - 126	4" ID Sch. 80 PVC
RJR-202-MW14	1174224.94	626580.41	624.36	627.04	161.1	15	145.1 - 160.9	4" ID Sch. 80 PVC
RJR-202-MW15	1173806.65	626511.67	637.49	640.99	122	10	109 - 119	4" ID Sch. 80 PVC
RJR-202-MW16	1173940.07	627232.64	629.05	631.33	158	15	139 - 154	4" ID Sch. 80 PVC
RJR-202-MW17	1174262.40	626832.19	629.76	631.85	50.5	10	40.5 - 50.5	4" ID Sch. 80 PVC
RJR-202-MW18	1174260.85	626839.15	629.66	631.60	178	9.6*	163 - 172.6	4" ID Sch. 80 PVC
RJR-202-MW20	1174141.73	626713.69	633.40	635.69	115.1	10	99.7 - 109.7	4" ID Sch. 80 PVC
RJR-202-MW22	1174048.45	626678.01	639.97	639.29	123.4	9.5*	110.4 - 119.9	4" ID Sch. 80 PVC
RJR-202-MW25	1173888.17	626814.71	629.45	630.91	69	10	59 - 69	4" ID Sch. 80 PVC
RJR-202-MW26	1173880.83	626816.22	629.20	631.25	183.5	10	173 - 183	4" ID Sch. 80 PVC
RJR-202-MW27	1173867.47	626722.03	633.41	635.38	90	10	80 - 90	4" ID Sch. 80 PVC
RJR-202-MW28	1173878.00	626714.70	634.14	636.28	162	10	148.7 - 158.7	4" ID Sch. 80 PVC
RJR-202-MW30	1173932.35	626666.16	637.05	639.43	175.7	10	160.4 - 170.4	4" ID Sch. 80 PVC
RJR-202-MW31	1173973.88	626519.93	636.58	638.34	80	10	70 - 80	4" ID Sch. 80 PVC
RJR-202-MW32	1173982.81	626523.34	636.47	638.15	175	10	161.6 - 171.6	4" ID Sch. 80 PVC
RJR-202-MW33	1174077.02	626587.26	635.43	637.05	94	10	84 - 94	4" ID Sch. 80 PVC
RJR-202-MW34	1174082.36	626584.00	635.40	637.20	175	10	159.7 - 169.7	4" ID Sch. 80 PVC
RJR-202-MW35	1174166.42	626633.03	632.03	633.42	74	10	64 - 74	4" ID Sch. 80 PVC
RJR-202-MW36	1174172.70	626639.79	631.69	632.95	170.8	10	155.5 - 165.5	4" ID Sch. 80 PVC

* Prepack screen installed.

Permanent wells installed using hollow-stem auger or air-rotary drilling techniques. Existing wells installed by SAIC not included.

Horizontal coordinates referenced to the U.S. State Plane Coordinate System, Alabama East Zone, North American Datum of 1983 (NAD83).

Elevations referenced to the North American Vertical Datum of 1988 (NAVD88).

4" ID Sch. 80 PVC - 4-inch inside diameter, Schedule 80, polyvinyl chloride.

bgs - Below ground surface.

ft - Feet.

amsl - Above mean sea level.

cuttings were logged to determine lithologic changes and the approximate depth of groundwater encountered during drilling. This information was used to determine the optimal placement of the monitoring well screen interval and to provide site-specific geologic and hydrogeologic information. Soil characteristics were described using the “Burmeister Identification System” described in Hunt (1986) and the Unified Soil Classification System (USCS) as outlined in the American Society for Testing and Materials (ASTM) Method D 2488 (ASTM, 2000). The lithological logs are included in Appendix C.

Upon reaching the target depth in each borehole, a 10-foot-length of 4-inch ID, 0.010-inch continuous slot, Schedule 80 polyvinyl chloride (PVC) screen with a PVC end cap (or 3-foot PVC sump) was placed through the auger to the bottom of the borehole. The screen and end cap (or sump) were attached to 4-inch ID, flush-threaded Schedule 80 PVC riser. A filter pack consisting of Number 1 filter sand (environmentally safe, clean fine sand, sieve size 20 to 40) was tremied around the well screen to approximately 5 feet above the top of the well screen as the augers were removed. The well was surged using a solid PVC surge block for approximately 10 minutes, or until no more settling of the sand pack occurred inside the borehole. A bentonite seal, consisting of approximately 5 feet of bentonite pellets, was placed immediately on top of the filter pack and hydrated with potable water. In wells where the bentonite seal was installed below the water table surface, the bentonite pellets were allowed to hydrate in the groundwater. Bentonite seal placement and hydration followed procedures in the SAP.

Bentonite-cement grout was tremied into the remaining annular space of the well from the top of the bentonite seal to approximately ground surface. A locking protective steel casing was placed over the PVC well riser, and a concrete pad was constructed around the wellhead. Four protective steel posts were installed around the well pad.

2.3.4.2 Bedrock Monitoring Wells

The bedrock monitoring wells were installed using an air-rotary drill rig equipped with a 12- or 14-inch percussion bit or rotary bit, or a 9-inch ODEX air rotary bit. The borehole at each well location was advanced from ground surface to approximately 5 feet into competent bedrock. Eight-inch or 10-inch ID carbon steel International Pipe Standard (IPS) outer casing was installed in the borehole from ground surface to the bottom of the borehole. A minimum of 2 inches of annular space was maintained between the outer casing and the borehole wall except at two well locations (RJR-202-MW22 and RJR-202-MW30), where the casing was installed with a 9-inch ODEX bit. The outer casing was grouted in place using a tremie pipe suspended in the annulus outside the casing. Bentonite-cement grout was mixed using approximately 6.5 to 7

gallons of water and 5 pounds of bentonite per 94-pound bag of Type II Portland cement. After allowing the grout to cure for a minimum of 48 hours, core samples were collected from select wells using a PQ3 or HQ wireline core barrel. Core samples were collected continuously from the top of bedrock to a minimum of 20 feet into competent bedrock. Following core sample collection, a 7.8-inch air percussion or rotary bit was used to ream the hole into competent bedrock a minimum of 15 feet below the bottom of the surface casing. Water was the only lubricant used during drilling operations.

A 4-inch monitoring well was installed through the outer casing at each well location. The well casing consisted of 4-inch ID, threaded, flush-joint, Schedule 80 PVC pipe. A 10- or 15-foot length of threaded, flush-joint, 0.010-inch continuous wrap PVC well screen was attached to the bottom of the well casing. Prepack screens were installed in two of the wells (RJR-202-MW18 and RJR-202-MW22) because voids were encountered within the screened interval of the wells. The prepack screen consisted of an outer Schedule 40 PVC factory slot screen and an inner Schedule 80 PVC continuous wrap well screen. A gravel pack consisting of 20/40 silica sand was installed between the two screens.

Either a 3- or 5-foot-long sump or a PVC end cap, consisting of 4-inch ID, threaded, flush-joint Schedule 80 PVC pipe, was attached to the bottom of the screen. After the casing and screen materials were lowered into the boring, a gravel pack (20/40 silica sand) was installed around the well screen, and the inside casing was grouted from the top of the gravel pack to ground surface. The gravel pack was tremied in place from the bottom of the sump to approximately 5 feet above the top of the screen. An approximately 5-foot-thick bentonite seal was placed above the gravel pack. A bentonite-cement mixture (described above) or a high-solids bentonite was tremied into the remaining annular space from the top of the bentonite seal to approximately ground surface. A locking protective steel casing was placed over the PVC well riser, and a concrete pad was constructed around the well. Four protective steel posts were installed around the well pad.

2.3.4.3 Well Development

The wells were developed by surging and pumping with a submersible pump in accordance with methodology outlined in the SAP. The submersible pump used for well development was moved in an up-and-down fashion to encourage any residual well installation materials to enter the well. These materials were then pumped out of the well to re-establish the natural hydraulic flow conditions. Development continued until the water turbidity was equal to or less than 20 nephelometric turbidity units (NTU), or for a maximum of 12 hours. The well development logs are included in Appendix D.

2.3.5 Water Level Measurements

The depth to groundwater was measured in wells at the site on June 13 and October 2, 2001, following procedures outlined in the SAP. Depth to groundwater was measured with an electronic water-level meter. Measurements were referenced to the top of the PVC well casing, as summarized in Table 2-5. The meter probe and cable were cleaned after use at each well, following decontamination methodology presented in the SAP.

2.3.6 Groundwater Sampling

For the purpose of the supplemental RI, pre-existing monitoring wells RJ-G05, RJ-G06, and RJ-G07 were designated RJR-202-MW01, RJR-202-MW02, and RJR-202-MW03, respectively. A total of 46 groundwater samples were collected from 30 monitoring wells (including 3 pre-existing wells) at Range J. Monitoring wells RJR-202-MW01 through RJR-202-MW16 were sampled on two separate occasions: in April 1999 and in May 2001. Monitoring well RJR-202-MW17 was not sampled because the well was dry at the time of sample collection. Subsequent attempts to sample this well were also unsuccessful. The well/groundwater sample locations are shown on Figure 2-3. The groundwater sampling locations and rationale are listed in Table 2-1. The groundwater sample designations and analytical parameters are listed in Table 2-6.

Sample Collection. Groundwater sampling was performed following procedures outlined in the SAP. Groundwater was sampled after purging a minimum of three well volumes and after field parameters (i.e., temperature, pH, dissolved oxygen, specific conductivity, oxidation-reduction potential, and turbidity) stabilized. Purging and sampling were performed with a mechanical pump (i.e., peristaltic, submersible, or bladder pump) equipped with Teflon™ tubing. Samples for VOC analysis collected using a peristaltic pump were collected via the “tube evacuation” method. Field parameters were measured using a calibrated water-quality meter. Field parameter readings are summarized in Table 2-7. Sample collection logs are included in Appendix B. The samples were analyzed for the parameters listed in Table 2-6 using methods outlined in Section 2.5.

2.3.7 Slug Testing

Slug tests were performed at seven wells to determine hydraulic conductivity of groundwater in residuum and bedrock at the site. Slug tests were also performed by SAIC at RJR-202-MW03. Slug testing locations were chosen based on purge rates recorded during well development procedures. The well locations were selected to produce results representing extreme hydraulic conditions at the site. Two slug tests were carried out at each well, a rising head test and a

Table 2-5

**Groundwater Elevations
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 1 of 2)

Well Location	Date	Depth to Water (ft BTOC)	Top of Casing Elevation (ft amsl)	Ground Elevation (ft amsl)	Groundwater Elevation (ft amsl)
RJR-202-MW01	2-Oct-01	65.20	636.42	634.82	571.22
	13-Jun-01	59.80			576.62
RJR-202-MW02	2-Oct-01	68.93	640.06	638.76	571.13
	13-Jun-01	63.56			576.50
RJR-202-MW03	2-Oct-01	69.28	640.48	638.86	571.20
	13-Jun-01	63.99			576.49
RJR-202-MW04	2-Oct-01	59.04	630.56	629.59	571.52
	13-Jun-01	53.40			577.16
RJR-202-MW05	2-Oct-01	62.10	633.12	631.10	571.02
	13-Jun-01	59.59			573.53
RJR-202-MW06	2-Oct-01	69.68	640.68	638.27	571.00
	13-Jun-01	64.13			576.55
RJR-202-MW07	2-Oct-01	56.57	627.57	625.21	571.00
	13-Jun-01	50.84			576.73
RJR-202-MW08	2-Oct-01	60.75	632.15	629.60	571.40
	13-Jun-01	55.28			576.87
RJR-202-MW09	2-Oct-01	66.71	637.80	635.70	571.09
	13-Jun-01	61.22			576.58
RJR-202-MW10	2-Oct-01	69.85	641.05	639.04	571.20
	13-Jun-01	64.51			576.54
RJR-202-MW11	2-Oct-01	68.94	639.76	637.66	570.82
	13-Jun-01	63.38			576.38
RJR-202-MW12	2-Oct-01	67.79	638.82	637.35	571.03
	13-Jun-01	62.28			576.54
RJR-202-MW13	2-Oct-01	62.93	633.92	632.05	570.99
	13-Jun-01	57.32			576.60
RJR-202-MW14	2-Oct-01	56.25	627.04	624.36	570.79
	13-Jun-01	50.40			576.64
RJR-202-MW15	2-Oct-01	70.09	640.99	637.49	570.90
	13-Jun-01	64.47			576.52
RJR-202-MW16	2-Oct-01	59.85	631.33	629.05	571.48
	13-Jun-01	54.11			577.22
RJR-202-MW17	2-Oct-01	NA	631.85	629.76	NA
	13-Jun-01	NA			NA
RJR-202-MW18	2-Oct-01	60.77	631.60	629.66	570.83
	13-Jun-01	55.04			576.56
RJR-202-MW20	2-Oct-01	64.84	635.69	633.40	570.85
	13-Jun-01	59.21			576.48
RJR-202-MW22	2-Oct-01	68.40	639.29	639.97	570.89
	13-Jun-01	62.86			576.43

Table 2-5

**Groundwater Elevations
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 2 of 2)

Well Location	Date	Depth to Water (ft BTOC)	Top of Casing Elevation (ft amsl)	Ground Elevation (ft amsl)	Groundwater Elevation (ft amsl)
RJR-202-MW25	2-Oct-01	59.93	630.91	629.45	570.98
	13-Jun-01	54.39			576.52
RJR-202-MW26	2-Oct-01	60.30	631.25	629.20	570.95
	13-Jun-01	54.72			576.53
RJR-202-MW27	2-Oct-01	64.52	635.38	633.41	570.86
	13-Jun-01	58.88			576.50
RJR-202-MW28	2-Oct-01	65.47	636.28	634.14	570.81
	13-Jun-01	59.80			576.48
RJR-202-MW30	2-Oct-01	68.65	639.43	637.05	570.78
	13-Jun-01	63.00			576.43
RJR-202-MW31	2-Oct-01	67.38	638.34	636.58	570.96
	13-Jun-01	61.79			576.55
RJR-202-MW32	2-Oct-01	67.42	638.15	636.47	570.73
	13-Jun-01	61.81			576.34
RJR-202-MW33	2-Oct-01	66.12	637.05	635.43	570.93
	13-Jun-01	60.45			576.60
RJR-202-MW34	2-Oct-01	66.44	637.20	635.40	570.76
	13-Jun-01	60.66			576.54
RJR-202-MW35	2-Oct-01	62.45	633.42	632.03	570.97
	13-Jun-01	56.74			576.68
RJR-202-MW36	2-Oct-01	62.16	632.95	631.69	570.79
	13-Jun-01	56.45			576.50

Elevations referenced to the North American Vertical Datum of 1988 (NAVD88).

amsl - Above mean sea level.

BTOC - Below top of casing.

ft - Feet.

NA - Not available, well was dry.

Table 2-6

Groundwater Sample Designations and Analytical Parameters
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 1 of 4)

Sample Location	Sample Designation	QA/QC Samples			Analytical Parameters
		Field Duplicates	Field Splits	MS/MSD	
RJR-202-MW01	RJR-202-MW01-GW-JB3001-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW01-GW-JB3019-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW02	RJR-202-MW02-GW-JB3002-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW02-GW-JB3020-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW03	RJR-202-MW03-GW-JB3003-REG	RJR-202-MW03-GW-JB3004-FD	RJR-202-MW03-GW-JB3005-FS		TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW03-GW-JB3021-REG	RJR-202-MW03-GW-JB3022-FD			TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW04	RJR-202-MW04-GW-JB3006-REG			RJR-202-MW04-GW-JB3006-MS/MSD	TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW04-GW-JB3024-REG			RJR-202-MW04-GW-JB3024-MS/MSD	TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW05	RJR-202-MW05-GW-JB3007-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW05-GW-JB3025-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW06	RJR-202-MW06-GW-JB3008-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW06-GW-JB3026-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW07	RJR-202-MW07-GW-JB3009-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW07-GW-JB3027-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW08	RJR-202-MW08-GW-JB3010-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW08-GW-JB3028-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness

Table 2-6

Groundwater Sample Designations and Analytical Parameters
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 2 of 4)

Sample Location	Sample Designation	QA/QC Samples			Analytical Parameters
		Field Duplicates	Field Splits	MS/MSD	
RJR-202-MW09	RJR-202-MW09-GW-JB3011-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW09-GW-JB3029-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW10	RJR-202-MW10-GW-JB3012-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW10-GW-JB3030-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW11	RJR-202-MW11-GW-JB3013-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW11-GW-JB3031-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW12	RJR-202-MW12-GW-JB3014-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW12-GW-JB3032-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW13	RJR-202-MW13-GW-JB3015-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW13-GW-JB3033-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW14	RJR-202-MW14-GW-JB3016-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW14-GW-JB3034-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW15	RJR-202-MW15-GW-JB3017-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW15-GW-JB3035-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW16	RJR-202-MW16-GW-JB3018-REG				TCL VOCs, TCL SVOCs, and CWM breakdown products
	RJR-202-MW16-GW-JB3036-REG	RJR-202-MW16-GW-JB3037-FD			TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness

Table 2-6

Groundwater Sample Designations and Analytical Parameters
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 3 of 4)

Sample Location	Sample Designation	QA/QC Samples			Analytical Parameters
		Field Duplicates	Field Splits	MS/MSD	
RJR-202-MW18	RJR-202-MW18-GW-JB3040-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW20	RJR-202-MW20-GW-JB3042-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW22	RJR-202-MW22-GW-JB3044-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW25	RJR-202-MW25-GW-JB3047-REG			RJR-202-MW25-GW-JB3047-MS/MSD	TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW26	RJR-202-MW26-GW-JB3048-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW27	RJR-202-MW27-GW-JB3049-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW28	RJR-202-MW28-GW-JB3050-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW30	RJR-202-MW30-GW-JB3052-REG	RJR-202-MW30-GW-JB3053-FD			TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW31	RJR-202-MW31-GW-JB3054-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW32	RJR-202-MW32-GW-JB3055-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW33	RJR-202-MW33-GW-JB3056-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW34	RJR-202-MW34-GW-JB3057-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness

Table 2-6

**Groundwater Sample Designations and Analytical Parameters
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 4 of 4)

Sample Location	Sample Designation	QA/QC Samples			Analytical Parameters
		Field Duplicates	Field Splits	MS/MSD	
RJR-202-MW35	RJR-202-MW35-GW-JB3058-REG	RJR-202-MW35-GW-JB3059-FD			TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness
RJR-202-MW36	RJR-202-MW36-GW-JB3060-REG				TCL VOCs, TAL Metals, Dissolved Metals, TOC, Nitrate, Nitrite, Sulfate, Sulfite, TDS, TSS, and Hardness

CWM - Chemical warfare material.

FD - Field duplicate.

FS - Field split.

MS/MSD - Matrix spike/matrix spike duplicate.

QA/QC - Quality assurance/quality control.

REG - Regular field sample.

SVOC - Semivolatile organic compound.

TAL - Target analyte list.

TCL - Target compound list.

TOC - Total organic carbon.

TDS - Total dissolved solids.

TSS - Total suspended solids.

VOC - Volatile organic compound.

Table 2-7

**Groundwater Field Parameters
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 1 of 2)

Sample Location	Sample Date	Specific Conductivity (mS/cm) ^a	Dissolved Oxygen (mg/L)	ORP (mV)	Temperature (°C)	Turbidity (NTU)	pH (SU)
RJR-202-MW01	15-Apr-99	0.209	9.22	261	16.78	0.0	7.91
	18-May-01	0.231	11.29	317	21.84	0.3	7.70
RJR-202-MW02	16-Apr-99	0.161	10.73	222	16.25	0.0	7.99
	24-May-01	0.267	7.17	235	18.10	9.5	7.33
RJR-202-MW03	19-Apr-99	0.102	9.74	203	16.56	0.0	8.10
	30-May-01	0.123	9.79	319	17.53	3.3	8.21
RJR-202-MW04	19-Apr-99	0.196	7.85	31	16.63	219 ^b	7.78
	17-May-01	0.316	8.11	NR	19.80	2.4	7.06
RJR-202-MW05	19-Apr-99	0.122	8.45	221	16.39	100 ^b	6.38
	17-May-01	0.188	10.32	426	21.04	0.7	6.69
RJR-202-MW06	21-Apr-99	0.251	7.45	202	17.28	0.0	8.36
	16-May-01	0.259	10.40	196	17.28	9.8	9.93
RJR-202-MW07	27-Apr-99	0.314	8.26	274	16.48	0.0	8.88
	17-May-01	0.289	10.27	238	20.76	5.1	9.58
RJR-202-MW08	27-Apr-99	0.306	5.42	230	16.79	0.0	9.23
	23-May-01	0.363	9.17	99	18.88	2.3	9.42
RJR-202-MW09	26-Apr-99	0.264	5.72	175	18.44	22	8.80
	29-May-01	0.301	8.28	254	18.64	6.8	8.52
RJR-202-MW10	29-Apr-99	0.301	4.06	274	16.10	0.0	8.11
	30-May-01	0.221	5.74	288	16.84	0.0	8.68
RJR-202-MW11	28-Apr-99	0.265	0.95	200	18.10	0.0	8.00
	30-May-01	0.209	NR	260	17.30	0.0	7.96
RJR-202-MW12	28-Apr-99	0.210	8.50	282	18.14	0.0	8.53
	29-May-01	0.263	9.87	300	17.12	1.3	8.13
RJR-202-MW13	20-Apr-99	0.192	7.50	242	16.93	0.0	7.95
	21-May-01	0.222	8.25	245	21.06	8.1	8.78
RJR-202-MW14	17-Apr-99	0.343	6.24	323	16.91	0.0	7.96
	23-May-01	0.315	7.21	270	16.40	1.4	7.17
RJR-202-MW15	26-Apr-99	0.252	6.58	205	16.56	0.0	8.46
	15-May-01	0.309	9.10	214	20.26	9.2	8.77

Table 2-7

**Groundwater Field Parameters
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 2 of 2)

Sample Location	Sample Date	Specific Conductivity (mS/cm) ^a	Dissolved Oxygen (mg/L)	ORP (mV)	Temperature (°C)	Turbidity (NTU)	pH (SU)
RJR-202-MW16	20-Apr-99	0.214	6.40	197	17.54	18	8.68
	16-May-01	0.173	8.22	280	20.84	6.2	8.61
RJR-202-MW18	23-May-01	0.274	8.23	250	17.30	4.5	7.11
RJR-202-MW20	29-May-01	0.301	12.75	255	17.53	2.5	7.95
RJR-202-MW22	25-May-01	0.289	8.77	187	20.78	62	8.25
RJR-202-MW25	15-May-01	0.298	6.92	164	17.70	45	9.74
RJR-202-MW26	11-May-01	0.192	11.22	313	22.12	7.4	8.20
RJR-202-MW27	10-May-01	0.289	10.40	95	18.16	2.5	10.17
RJR-202-MW28	10-May-01	0.243	7.52	285	20.48	4.3	8.36
RJR-202-MW30	24-May-01	0.338	11.80	255	17.40	5.7	7.09
RJR-202-MW31	14-May-01	0.367	7.12	332	21.34	9.4	7.89
RJR-202-MW32	9-May-01	0.191	12.29	243	18.81	5.5	9.30
RJR-202-MW33	23-May-01	2.020	8.67	40	18.30	17	12.48 ^c
RJR-202-MW34	16-May-01	0.226	11.29	310	18.34	6.7	8.13
RJR-202-MW35	21-May-01	0.980	8.35	NR	19.50	7.0	9.73
RJR-202-MW36	22-May-01	0.351	11.51	294	18.87	8.6	8.31

^a Specific conductivity values standardized to millisiemens per centimeter.^b Turbidities lower during May 2001 sampling event due to use of lower flow purging and sampling techniques.^c Result artificially elevated, probably due to grout contamination of the well.

°C - Degrees Celsius.

GW - Groundwater.

mg/L - Milligrams per liter.

mS/cm - Millisiemens per centimeter.

mV - Millivolts.

NR - Not recorded due to equipment malfunction.

NTU - Nephelometric turbidity units.

ORP - Oxidation-reduction potential.

SU - Standard units.

falling head test, unless the static water level measured was below the top of the screened interval, in which case only a rising head test was carried out. A detailed description of the methods used is presented in Appendix E.

The objective of performing the slug tests was to provide order-of-magnitude hydraulic conductivity values at several wells penetrating three zones within the underlying residuum and bedrock. The assumptions associated with the Cooper, Bredehoeft, Papadopulos Type Curve matching are the ideal conditions based on which the methodology (curve-matching) is theoretically valid. In reality, the conditions are rarely perfect in matching those conditions on a large scale. However, the departure from the assumptions does not itself invalidate the slug test results for two reasons: 1) within the effective zone of the slug test, which includes the formations immediately surrounding the tested well, the assumptions are still valid and the slug test results are useable; and 2) away from the test well, as the assumptions become harder to justify, the validity of the slug test result becomes increasingly questionable. Therefore, the slug test results from one well are valid for the geologic formation immediately surrounding the tested well. The results from a single test were not extrapolated to a large area. As provided in Appendix E, eight different wells were tested at Range J to provide a range of hydraulic conductivity values to permit statistically meaningful hydraulic values to be calculated.

2.4 Surveying of Sample Locations

Monitoring well and sample locations were surveyed using global positioning system survey and conventional civil survey techniques described in the SAP. Horizontal coordinates were referenced to the U.S. State Plane Coordinate System, Alabama East Zone, North American Datum of 1983. Elevations were referenced to the North American Vertical Datum of 1988. Horizontal coordinates and elevations are included in Appendix F.

2.5 Analytical Program

Samples collected during the RI were analyzed for various chemical parameters based on the potential site-specific chemicals and on requirements of EPA, the Alabama Department of Environmental Management (ADEM), FTMC, and USACE. Target analyses for samples collected during the supplemental RI at Range J included the following parameters using EPA SW-846 methods, including Update III methods where applicable.:

- Target compound list (TCL) VOCs – EPA Method 8260B
- TCL semivolatile organic compounds (SVOC) – EPA Method 8270C

- Target analyte list metals – EPA Method 6010B/7000
- CWM breakdown products (including orthosulfur compounds) – EPA Methods 8321 (modified) and 8270 (modified).

Additionally, the groundwater samples were analyzed for the following parameters to provide data to evaluate natural attenuation and remediation options:

- Hardness – Method E130.1
- Total organic carbon – EPA Method 9060
- Total dissolved solids – Method E160.1
- Total suspended solids – Method E160.2
- Nitrate/nitrite – Method E300
- Sulfate/sulfite – Method E377.1.

2.6 Sample Preservation, Packaging, and Shipping

Sample preservation, packaging, and shipping followed requirements specified in the SAP. Sample containers, sample volumes, preservatives, and holding times for the analyses performed in this RI are listed in the SAP. Sample documentation and chain-of-custody records were completed as specified in the SAP.

Completed analysis request and chain-of-custody records (Appendix B) were secured and included with each shipment of sample coolers to either Quanterra Environmental Services in Knoxville, Tennessee, or EMAX Laboratories, Inc. in Torrance, California. Split samples were shipped to the USACE South Atlantic Division Laboratory in Marietta, Georgia.

2.7 Investigation-Derived Waste Management and Disposal

Investigation-derived waste (IDW) was managed and disposed as outlined in the SAP. The IDW generated during the RI at Range J was segregated as follows:

- Drill cuttings
- Purge water from well development, sampling activities, and decontamination fluids
- Spent well materials and personal protective equipment.

Solid IDW was stored in lined roll-off bins prior to characterization and final disposal. Solid IDW was characterized using toxicity characteristic leaching procedure analysis. Based on the results, drill cuttings, spent well materials, and personal protective equipment generated during

field activities were disposed as nonhazardous waste at the Industrial Waste Landfill on the Main Post of FTMC.

Liquid IDW was stored in a portable frac tank at Range J pending waste characterization. Liquid IDW was characterized by VOC, SVOC, and metals analyses. Based on the analyses, liquid IDW was discharged as nonhazardous waste.

2.8 Variances/Nonconformances

Twelve variances to the SFSPs were recorded during completion of the RI at Range J, Parcel 202(7). The variances did not alter the intent of the investigation or the sampling rationale presented in the SFSPs. The variances are summarized in Table 2-8, and the variance reports are included in Appendix G.

No nonconformances were documented during RI field activities at Range J.

2.9 Data Quality

The field sample analytical data are presented in tabular form in Appendix H. The field samples were collected, documented, handled, analyzed, and reported in a manner consistent with the RI work plan; the FTMC SAP and quality assurance plan; and standard, accepted methods and procedures. Data were reported and evaluated in accordance with Corps of Engineers South Atlantic Savannah Level B criteria (USACE, 1994) and the stipulated requirements for the generation of definitive data presented in the SAP. Chemical data were reported via hard-copy data packages by the laboratory using Contract Laboratory Program-like forms.

Data Validation. The reported analytical data were validated in accordance with EPA National Functional Guidelines by Level III criteria. Appendix I includes data validation summary reports that discuss the results of the validation. Selected results were rejected or otherwise qualified based on the implementation of accepted data validation procedures and practices. These qualified parameters are highlighted in the reports. The validation-assigned qualifiers were added to the FTMC Shaw Environmental Management System™ database for tracking and reporting. The data presented in this report, except where qualified, meet the principle data quality objective for this investigation.

Table 2-8

**Variances to the Site-Specific Work Plans
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 1 of 2)

Variance to the SFSP	Justification for Variance	Impact to Site Investigation
Direct-push soil boring locations RJR-202-GP11, RJR-202-GP12, and RJR-202-GP16 were relocated at the request of the USACE.	The soil borings were relocated to more accurately determine the presence of contamination. RJR-202-GP11 was moved approximately 20 feet east near mounded soil material located inside the chain link fence. RJR-202-GP12 was moved approximately 20 feet east inside the chain link fence area. RJR-202-GP16 was moved approximately 25 feet southwest and next to a corroded 55-gallon drum.	None. Relocating the soil borings more accurately determined the nature and extent of contamination at the site.
Two subsurface samples were collected from soil boring RJR-202-MW10.	One additional subsurface soil sample was collected from RJR-202-MW10 because of elevated photoionization detector readings at 19-21 feet bgs.	The additional subsurface soil sample provided additional data to determine the presence or absence of contamination at the site.
In monitoring well RJR-202-MW16, gravel was placed into the annular space between the 10-inch outer casing and the borehole from 55 to 41 feet bgs. The SFSP proposed the use of grout in the annular well space.	During grouting of the annular space between the 10-inch outer casing and the borehole at RJR-202-MW16 the silty-sand formation began taking grout. Several unsuccessful attempts were made to thicken the grout to seal off the silty-sand formation from the borehole. A decision was made by the USACE oversight geologist and IT project geologist to use coarse gravel to seal off the silty-sand formation so that grouting could be completed and the outer casing set in the borehole.	None. The use of coarse gravel allowed for successful installation of the well.
Rock core samples were not collected at bedrock monitoring well locations RJR-202-MW13 and RJR-202-MW15.	Bedrock encountered during air-rotary drilling and coring activities was severely fractured, and because of saturated sand lenses, the core barrel locked inside of the borehole causing lost water circulation that prevented rock coring samples from being recovered from the borehole. A minimum of three unsuccessful attempts were made to obtain core samples at wells RJR-202-MW13 and RJR-202-MW15. A decision was made by the IT Site Manager, USACE geologist, and EPA subcontracted geologist to discontinue rock coring activities at these two wells. Rock samples from air-rotary cuttings were logged in the field by the IT field geologist.	None. Adequate coring data were collected from other wells at the site.
The SFSP proposed 10-inch inside diameter outer casing at monitoring well RJR-202-MW14. However, 10-inch outer casing and 8-inch inner casing were used to construct the well.	During the installation of the 10-inch outer casing into the fractured and weathered bedrock, the casing broke at 40 feet bgs. A decision was made by the IT Site Manager, USACE geologist, and EPA subcontractor geologist to install 8-inch casing inside the 10-inch outer casing. The 8-inch inner casing was installed to prevent potential vertical migration of contaminants during drilling and installation of the well.	None. The use of the 8-inch inner casing prevented potential vertical migration of contaminants during well installation.
The SFSP proposed the use of a 10-foot screen, a 5-foot sump, and a 5-foot sand pack above the well screen in monitoring well RJR-202-MW14. However, the well was constructed with a 15-foot screen, a 3-foot sump, and a 3-foot sand pack.	During drilling activities at RJR-202-MW14, formation sands caused the borehole walls to cave-in below the bottom of the 10-inch outer casing. Several attempts were made to keep the borehole open so that the well construction specification could be met. A 15-foot length of well screen was used during well construction to ensure the monitoring well would yield enough groundwater so that the well could be properly developed and sampled.	None. The use of a longer screen helped ensure that the well would yield sufficient water for sampling.

Table 2-8

**Variances to the Site-Specific Work Plans
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 2 of 2)

Variance to the SFSP	Justification for Variance	Impact to Site Investigation
The SFSP proposed the use of 10-foot well screens in wells RJR-202-MW11, RJR-202-MW12 and RJR-202-MW16. However, these wells were constructed with 15-foot PVC well screens.	To ensure RJR-202-MW11, RJR-202-MW12 and RJR-202-MW16 would yield enough groundwater so that the wells could be properly developed and sampled, 15 feet of well screen was used rather than 10 feet.	None. The use of longer screens helped ensure that the wells would yield sufficient water for sampling.
The SFSP proposed that RJR-202-MW13 be constructed with a 5-foot sump and a sand pack using No. 1 sand. RJR-202-MW13 was actually constructed with a 1-foot sump and a sand pack consisting of No. 4 sand.	During drilling activities at RJR-202-MW13 the borehole was advanced to 143 feet bgs, but collapsed due to flowing silt and sand from the formation. It was decided by the IT Site Manager, USACE geologist, and EPA subcontractor geologist to use a coarser-grained sand pack (No. 4) so that the well could be installed into the open borehole without further collapse.	None. The use of the coarser-grained sand pack allowed for successful installation of the well.
Groundwater samples were not collected from monitoring well RJR-202-MW17.	During drilling and monitoring well installation activities competent bedrock was encountered prior to reaching groundwater. Based upon previous drilling and well installation activities at Fort McClellan, groundwater was observed to migrate along the soil/bedrock interface. Therefore, a decision was made to install the well on top of competent bedrock with the intent of having groundwater enter the well screen during periods of heavy rainfall. To date, insufficient groundwater has been present in the well for sample collection. Because the BCT agreed in October 2001 that the vertical and horizontal extent of contaminants has been defined at Range J, there are no plans to attempt to collect a groundwater sample from RJR-202-MW17.	None. Sufficient groundwater data were collected at the site to adequately characterize the nature and extent of contamination.
Monitoring wells RJR-202-MW19, RJR-202-MW21, RJR-202-MW23, RJR-202-MW24 and RJR-202-MW29 were not installed.	Based on the groundwater analytical data obtained in the first phase of field activities, the extent of groundwater contamination was defined. Installation of monitoring wells RJR-202-MW19, RJR-202-MW21, RJR-202-MW23, RJR-202-MW24 and RJR-202-MW29 was deemed unnecessary by the BCT (October, 2001).	None. Sufficient groundwater data were collected at the site to adequately characterize the nature and extent of contamination.
The SFSP proposed installation of monitoring well RJR-202-MW18 using a 10-inch outer casing, a 10-foot section of continuous wrap PVC screen, and 20/40 silica sand filter pack. However, the well was installed with 8-inch outer casing and 10-foot factory-slotted PVC screen.	Because a void was encountered during drilling, there was concern that the 20/40 silica sand filter pack would not remain in place, thus jeopardizing the structural integrity of the well. After consultation with the USACE, a decision was made to install the well using a 10-foot prepacked factory-slotted screen.	None. Using a prepacked screen allowed for successful installation of the well.
Rock coring samples were not collected at wells RJR-202-MW26, RJR-202-MW28, RJR-202-MW32	A decision was made by USACE and IT Site Manager not to attempt rock coring at these wells because of low recovery percentage, lost circulation, and the availability of sufficient data from other wells at the site.	None. Adequate coring data were available from other wells at the site.

BCT - BRAC Cleanup Team.

bgs - below ground surface.

EPA - U.S Environmental Protection Agency.

SFSP - Site-Specific Field Sampling Plan.

ft - feet.

ID - inside diameter.

IT - IT Corporation.

ppm - parts per million.

PVC - polyvinyl chloride

USACE - U.S. Army Corps of Engineers.

3.0 Physical Characteristics of Study Area

This chapter describes the physical characteristics of Range J that are important to understanding the current nature and extent of contamination and the future transport of contaminants. These characteristics can be described in terms of demography and land reuse, meteorology, physiography, sensitive environments, soils, geology, hydrology, and hydrogeology.

3.1 Demography and Land Reuse

FTMC includes 45,679 acres of government-owned and formerly leased land situated in the foothills of the Appalachian Mountains of northeast Alabama. The post is located in Calhoun County (population 112,249), approximately 60 miles northeast of Birmingham (population 242,820), approximately 75 miles northwest of Auburn (population 42,987), and approximately 90 miles west of Atlanta (population 416,474), Georgia. The city of Anniston (population 24,276) adjoins the Main Post on the south and west. The city of Weaver (population 2,619) is approximately 1 mile northwest of the Main Post, and the city of Oxford (population 14,592) is approximately 5 miles south of Anniston (U.S. Census Bureau, Census 2000). Pelham Range is approximately 5 miles due west of the Main Post and adjoins Anniston Army Depot along its northern boundary. Within Calhoun County, 5 percent of the total labor force are in the armed forces. Of the remaining civilian labor force, the top five industries in which people are employed are: retail trade (18.7 percent), manufacturing, durable goods (12.3 percent), public administration (12.0 percent), manufacturing, non-durable goods (10.8 percent), and educational services (9.0 percent) (SAIC, 2000).

Projected land reuse for FTMC is presented in the *Fort McClellan Comprehensive Reuse Plan, Implementation Strategy* (EDAW, 1997). Pelham Range is projected for continued use by the Alabama Army National Guard as an active range for military training activities.

3.2 Meteorology

FTMC is situated in a temperate, humid climate. Summers are long and hot, and winters are usually short and mild to moderately cold. The climate is influenced by frontal systems moving from northwest to southeast, and temperatures change rapidly from warm to cool due to the inflow of northern air. The average annual temperature is 63 degrees Fahrenheit (°F). Summer temperatures usually reach 90°F or higher about 70 days per year, but temperatures above 100°F are rare. Freezing temperatures are common in winter but are usually of short duration. The first frost may arrive by late October. Snowfall averages 0.5 to 1 inch. On rare occasions, several

inches of snow accumulate from a single storm. At Anniston, the average date of the first 32°F temperature is November 6, and the last is March 30. This provides a growing season of 221 days (ESE, 1998).

The average annual rainfall is approximately 53 inches and is well distributed throughout the year, as indicated on Figure 3-1 (National Climatic Data Center, 2001). The more intense rains usually occur during the warmer months, and some flooding occurs nearly every year. Drought conditions are rare, though the entire southeastern United States has been experiencing drought conditions for the three years previous to this writing. Approximately 80 percent of the flood-producing storms are of the frontal type and occur in the winter and spring, lasting from 2 to 4 days each. Summer storms are usually thunderstorms with intense precipitation over small areas, and these sometimes result in serious local floods. Occasionally, several wet years or dry years occur in series. Annual rainfall records indicate no characteristic order or pattern.

Winds in the FTMC area are seldom strong and frequently blow down the valley from the northeast. However, there is no truly persistent wind direction. Normally, only light breezes or calm prevails, except during passages of cyclic disturbances, when destructive local wind storms develop, some into tornadoes, with winds of 100 miles per hour or more.

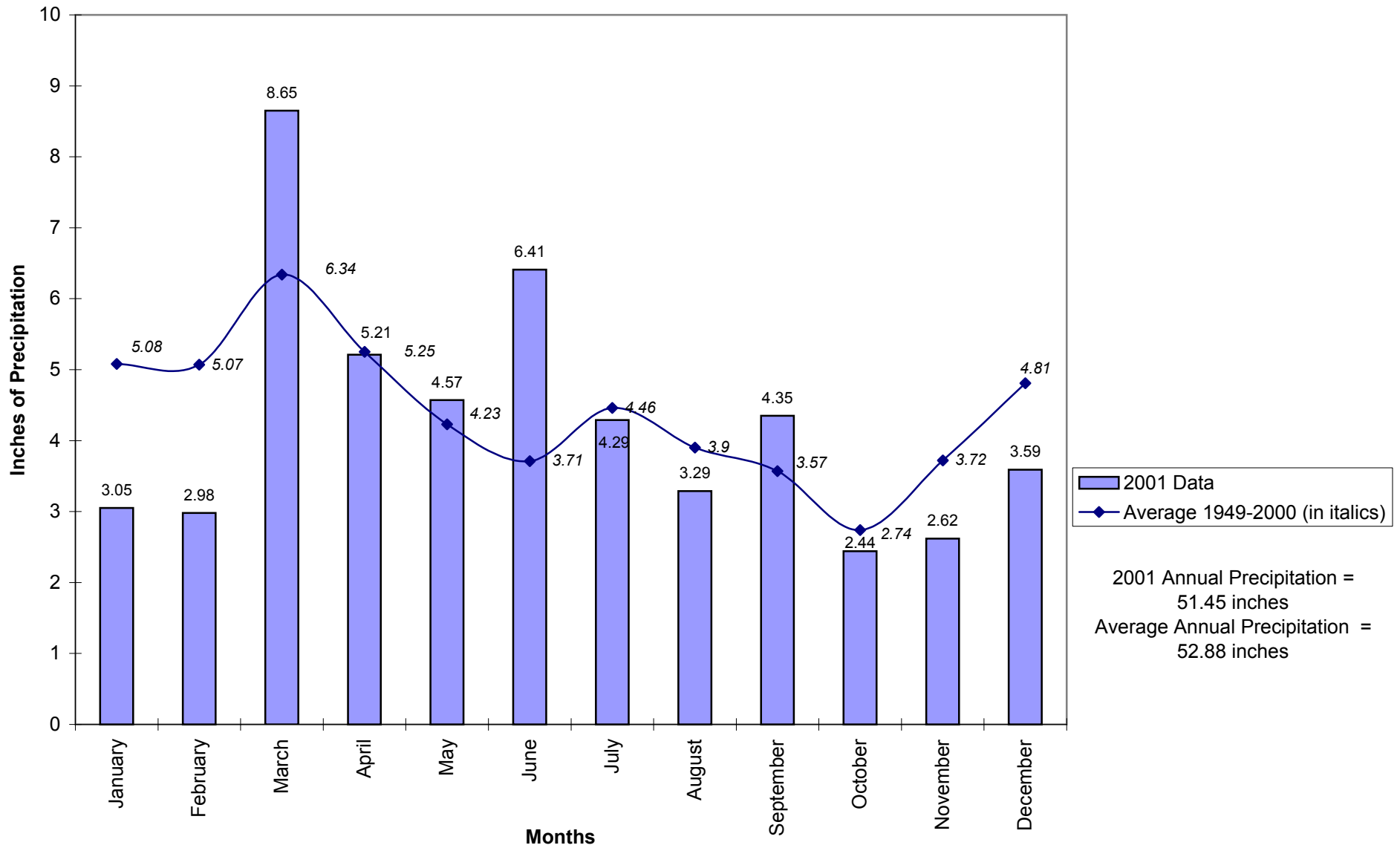
3.3 Physiography

Pelham Range and all but the easternmost portion of FTMC lie within the Valley and Ridge Province of the Appalachian Highlands. The portion of FTMC west of Choccolocco Creek lies within the Piedmont Province. Local relief on FTMC is in excess of 1,320 feet. The lower elevations (700 feet above mean sea level [msl]) occur along Cane Creek, near Baltzell Gate Road, while the maximum elevations (2,063 feet above msl) occur on Choccolocco Mountain, which traverses the area in a north/south direction, with the steep easterly slopes grading abruptly into Choccolocco Valley. The western slopes are more continuous, with the southern extension maintaining elevations up to 900 feet above msl near the western reservation boundary. The northern extension decreases in elevation in the vicinity of Reilly Airfield. The central portion of FTMC is characterized by flat to gently sloping land.

The topographic relief at Pelham Range is approximately 445 feet. The minimum elevation is 500 feet above msl, which occurs at the exit of Cane Creek from the range, and the maximum elevation is 945 feet above msl, near the southeastern boundary. The northern sector contains broad, rolling topography capped with isolated round knobs rising 75 to 90 feet above the

Figure 3-1

**2001 Precipitation and Average Annual Precipitation
Anniston, Alabama**



2001 data from National Climatic Data Center Unedited Local Climatological Data, Station 13871.
1949-2000 averaged data from National Weather Service, Normals and Records, Anniston, Alabama.

surrounding terrain. A large, relatively flat area called the Battle Drill Area is situated near the western boundary (SAIC, 2000).

Range J is located approximately midway along the axis of a northeast-southwest trending ridge at an elevation of approximately 640 feet amsl (Figure 3-2). To the northwest, the elevation rapidly drops off to less than 590 feet. South and southeast of the parcel, an unnamed intermittent stream flows towards the south and then swings abruptly to the west. This stream is an intermittent tributary to Cane Creek.

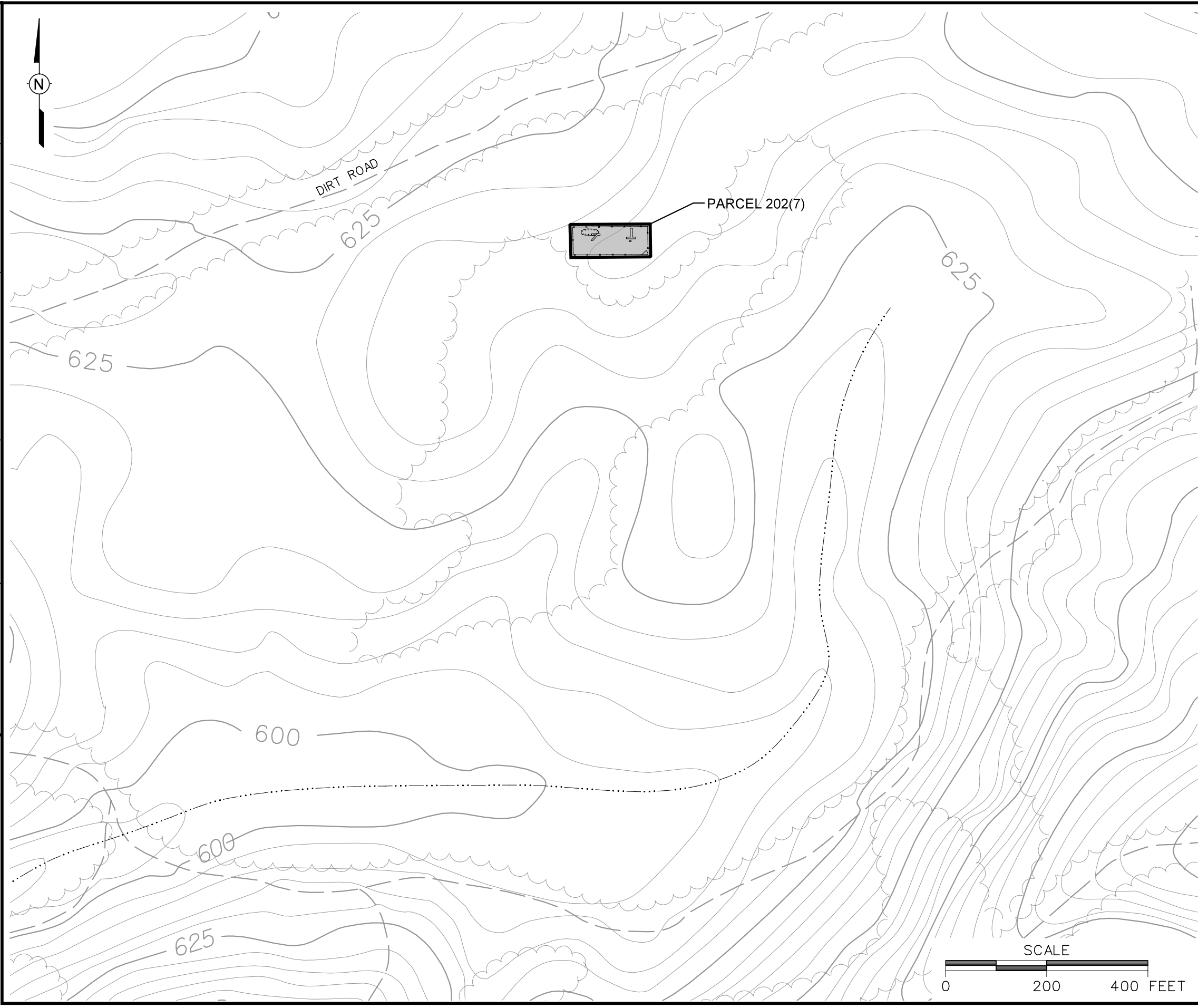
3.4 Sensitive Environments

3.4.1 Wetlands

FTMC has an estimated 3,424 acres of delineated wetlands. Major wetland communities were originally characterized and mapped in 1984. However, regulatory criteria for identifying wetlands have significantly changed since this original study was performed. Thus, the USACE performed a supplementary mapping and evaluation study in 1992 to identify larger wetland complexes (Reisz Engineering [Reisz], 1998). The following are recognized wetland communities located within FTMC (Reisz, 1998): Bottomland Hardwoods; Depressions; Mixed Shrub Communities; Shrub Depression; and Herbaceous Wetlands.

Wetland habitats at FTMC are generally located in various topographical depressions, near stream seepages, and in valleys along creek floodplains (Roy F. Weston, Inc. [Weston], 1990; SAIC 1993). The indicator plant species that assist in defining a wetland include water oaks, sweet gum, bulrush, needlerush, and cattail. The Main Post, Pelham Range, and Choccolocco Corridor have an abundance of wetlands representing important habitats for a wide variety of plants and animals. Wetland communities found on the Main Post are the Marcheta Hill Orchard Seep, Cane Creek Seep, South Branch of Cane Creek, and 200 acres west of the airstrip that comprise the tributary to Victoria Creek (Garland, 1996; USACE, 1992). Pelham Range wetland communities occur along the banks of Cane Creek, Willett Spring, and Cabin Creek Spring (Alabama Department of Conservation and Natural Resources, 1994a and 1994b). Additionally, wetland habitat potentially exists at or around the installation's lakes, namely, Lake Reilly, Lake Conteras, Lake Yahou, and Lake Willett, and along the nearly 10 miles of creeks, namely, Cane Creek and Cave Creek (Weston, 1990).

There are no designated wetlands in the immediate vicinity of Range J. The closest wetland area is approximately 3,500 feet southwest of the site, along Cane Creek (IT, 2002a).



LEGEND

UNIMPROVED ROADS AND PARKING

TOPOGRAPHIC CONTOURS
(CONTOUR INTERVAL - 5 FOOT)

TREES / TREELINE

PARCEL BOUNDARY

FENCE

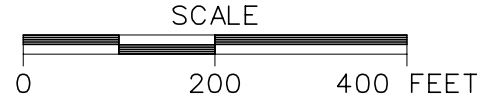
FORMER SOIL / DRUM DISPOSAL PIT

FORMER TRENCH EXCAVATION

SURFACE DRAINAGE / INTERMITTENT CREEK

FIGURE 3-2
TOPOGRAPHIC MAP
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018



3.4.2 Sensitive Habitats

FTMC operated under the guidelines of the Endangered Species Act of 1973, the regulations of the U.S. Fish and Wildlife Service (USFWS), Army Regulation 200-3, and the Endangered Species Management Plan (ESMP) (Garland, 1996). The overall objectives of the ESMP are to sustain the existing habitat that supports populations of species identified in the ESMP and to promote the augmentation of these species into unoccupied land that has similar habitats.

The ESMP identifies 11 Special Interest Natural Areas (SINA) on the Main Post. SINAs are locations where the habitat fosters one or more rare, threatened, or endangered species. Because these species are sensitive to environmental degradation, SINAs require management practices that promote the continued well being of these ecosystems. According to the ESMP, the 11 SINAs located on the Main Post include:

- Mountain Longleaf Community Complex
- Cave Creek Seep
- Moorman Hill Mountain Juniper
- Frederick Hill Aster Site
- Bains Gap Seep
- Marcheta Hill Crow-Poison Seep
- Marcheta Hill Orchid Seep
- South Branch of Cane Creek Seep
- Stanley Hill Chestnut Oak Forest
- Reynolds Hill Turkey Oak
- Davis Hill Honeysuckle.

Five SINAs are located on Pelham Range:

- Willett Springs
- Lloyd's Chapel Swale
- Impact Area Barren
- Cabin Club Spring
- Cane Creek Corridor.

There are no SINAs in the immediate vicinity of Range J. The closest SINA is approximately 1.5 miles west of Range J (IT, 2002a).

3.4.3 Threatened and Endangered Species

Rare species deserving unofficial protection and management measures in the State of Alabama are inventoried and ranked by the Alabama Natural Heritage Program. The sensitivity of these

rare species to environmental degradation is used to gauge the well-being of the habitat as a whole. Four species listed as endangered or threatened by the USFWS have been recorded on FTMC: Gray bat (*Myotis grisescens*), Blue shiner (*Cyprinella caerulea*), Mohr's barbara buttons (*Marshallia mohrii*), and Tennessee yellow-eyed grass (*Xyris tennesseensis*) (Garland, 1996). An additional species, the red-cockaded woodpecker (*Picoides borealis*), historically inhabited the installation but is no longer present at FTMC. Although the gray bat, Mohr's barbara buttons, and Tennessee yellow-eyed grass have been recorded at Pelham Range, none of these species occur in the vicinity of Range J. The blue shiner does not inhabit Pelham Range (Garland, 1996).

3.5 Soils

The soil associations found at FTMC and Pelham Range (U.S. Department of Agriculture [USDA], 1961), include:

- **Anniston-Allen, Decatur-Cumberland.** Alluvium, resulting from weathering of older saprolitic soils developed from sandstone, shale, and quartzite; deep, well-drained, level to moderately steep soils in valleys underlain by limestone and shale. Subsoil is dark red sandy clay loam. Cumberland and Decatur soils are dark reddish-brown gravelly loam developed from limestone saprolite source.
- **Clarksville-Fullerton.** Well-drained to moderately well-drained stony or cherty soils developed in the residuum of cherty limestone. This association is limited to Pelham Range. The soils are generally dark brown to dark gray-brown silt loam.
- **Rarden-Montevallo-Lehew.** Moderately deep or shallow soils or ridgetops and steep slopes and in local alluvium in draws. Soils are developed from the residuum of shale and fine-grained, micaceous sandstone; reddish-brown to dark gray-brown to yellow-brown silt loam, clay, or silty clay.
- **Stony Rough Land.** Shallow, steep, and stony soils formed from the weathering of sandstone, limestone, and Talladega Slate. Infiltration is slow; the soils contain many boulders and fragments with clayey residuum. This association underlies a large portion of the Main Post at FTMC.

In general, the soils are acidic to very strongly acidic (SAIC, 2000).

3.5.1 Site-Specific Soils

Soils at Range J, Parcel 202(7), are classified as the Clarksville-Fullerton series of soils. Specifically, the soil type is Fullerton Cherty Silt Loam, 6 to 10 percent slope (FcC2). Fullerton soil type is generally characterized by strongly acidic, well drained soils that have developed from the residuum of cherty limestone. These soils occur on wide ridges with sloping tops and

strongly sloping to moderately steep sides. The permeability of these soils is moderate to rapid. Some places have lost 75 percent of the original surface soil through erosion. The capacity to hold moisture is low to moderate. Natural fertility and organic matter are low. Fragments of chert are normal throughout the soils (USDA, 1961).

3.6 Geology

The regional geology in the vicinity of FTMC and Range J site-specific geology are discussed in the following sections.

3.6.1 Regional Geology

Calhoun County includes parts of two physiographic provinces, the Piedmont Upland Province and the Valley and Ridge Province. The Piedmont Upland Province occupies the extreme eastern and southeastern portions of the county and is characterized by metamorphosed sedimentary rocks. The generally accepted range in age of these metamorphics is Cambrian to Devonian.

The majority of Calhoun County, including the Main Post of FTMC, lies within the Appalachian fold-and-thrust structural belt (Valley and Ridge Province) where southeastward-dipping thrust faults with associated minor folding are the predominant structural features. The fold-and-thrust belt consists of Paleozoic sedimentary rocks that have been asymmetrically folded and thrust-faulted, with major structures and faults striking in a northeast-southwest direction.

Northwestward transport of the Paleozoic rock sequence along the thrust faults has resulted in the imbricate stacking of large slabs of rock referred to as thrust sheets. Within an individual thrust sheet, smaller faults may splay off the larger thrust fault, resulting in imbricate stacking of rock units within an individual thrust sheet (Osborne and Szabo, 1984). Geologic contacts in this region generally strike parallel to the faults, and repetition of lithologic units is common in vertical sequences. Geologic formations within the Valley and Ridge Province portion of Calhoun County have been mapped by Warman and Causey (1962), Osborne and Szabo (1984), and Moser and DeJarnette (1992) and vary in age from Lower Cambrian to Pennsylvanian.

The basal unit of the sedimentary sequence in Calhoun County is the Cambrian Chilhowee Group. The Chilhowee Group consists of the Cochran, Nichols, Wilson Ridge, and Weisner Formations (Osborne and Szabo, 1984) but in Calhoun County is either undifferentiated or divided into the Cochran and Nichols Formations and an upper, undifferentiated Wilson Ridge and Weisner Formation. The Cochran is composed of poorly sorted arkosic sandstone and

conglomerate with interbeds of greenish gray siltstone and mudstone. Massive to laminated greenish gray and black mudstone makes up the Nichols Formation, with thin interbeds of siltstone and very fine-grained sandstone (Osborne et al., 1988). These two formations are mapped only in the eastern part of the county.

The Wilson Ridge and Weisner Formations are undifferentiated in Calhoun County and consist of both coarse-grained and fine-grained clastics. The coarse-grained facies appears to dominate the unit and consists primarily of coarse-grained, vitreous quartzite, and friable, fine- to coarse-grained, orthoquartzitic sandstone, both of which locally contain conglomerate. The fine-grained facies consists of sandy and micaceous shale and silty, micaceous mudstone, which are locally interbedded with the coarse clastic rocks. The abundance of orthoquartzitic sandstone and quartzite suggests that most of the Chilhowee Group bedrock in the vicinity of FTMC belongs to the Weisner Formation (Osborne and Szabo, 1984).

The Cambrian Shady Dolomite overlies the Weisner Formation northeast, east, and southwest of the Main Post and consists of interlayered bluish-gray or pale yellowish-gray sandy dolomitic limestone and siliceous dolomite with coarsely crystalline, porous chert (Osborne et al., 1989). A variegated shale and clayey silt have been included within the lower part of the Shady Dolomite (Cloud, 1966). Material similar to this lower shale unit was noted in core holes drilled by the Alabama Geologic Survey on FTMC (Osborne and Szabo, 1984). The character of the Shady Dolomite in the FTMC vicinity and the true assignment of the shale at this stratigraphic interval are still uncertain (Osborne, 1999).

The Rome Formation overlies the Shady Dolomite and locally occurs to the northwest and southeast of the Main Post, as mapped by Warman and Causey (1962) and Osborne and Szabo (1984), and immediately to the west of Reilly Airfield (Osborne and Szabo, 1984). The Rome Formation consists of variegated, thinly interbedded grayish-red-purple mudstone, shale, and siltstone and greenish-red and light gray sandstone, with locally occurring limestone and dolomite. The Conasauga Formation overlies the Rome Formation and occurs along anticlinal axes in the northeastern portion of Pelham Range (Warman and Causey, 1962; Osborne and Szabo, 1984) and the northern portion of the Main Post (Osborne et al., 1997). The Conasauga Formation is composed of dark gray, finely to coarsely crystalline, medium- to thick-bedded dolomite with minor shale and chert (Osborne et al., 1989).

Overlying the Conasauga Formation is the Knox Group, which is composed of the Copper Ridge and Chepultepec dolomites of Cambro-Ordovician age. The Knox Group is undifferentiated in

Calhoun County and consists of light medium gray, fine to medium crystalline, variably bedded to laminated, siliceous dolomite and dolomitic limestone that weather to a chert residuum (Osborne and Szabo, 1984). The Knox Group underlies a large portion of the Pelham Range area.

The Ordovician Newala and Little Oak Limestones overlie the Knox Group. The Newala Limestone consists of light to dark gray, micritic, thick-bedded limestone with minor dolomite. The Little Oak Limestone is comprised of dark gray, medium- to thick-bedded, fossiliferous, argillaceous to silty limestone with chert nodules. These limestone units are mapped as undifferentiated at FTMC and in other parts of Calhoun County. The Athens Shale overlies the Ordovician limestone units. The Athens Shale consists of dark gray to black shale and graptolitic shale with localized interbedded dark gray limestone (Osborne et al., 1989). These units occur within an eroded “window” in the uppermost structural thrust sheet at FTMC and underlie much of the developed area of the Main Post.

Other Ordovician-aged bedrock units mapped in Calhoun County include the Greensport Formation, Colvin Mountain Sandstone, and Sequatchie Formation. These units consist of various siltstones, sandstones, shales, dolomites, and limestones and are mapped as one, undifferentiated unit in some areas of Calhoun County. The only Silurian-age sedimentary formation mapped in Calhoun County is the Red Mountain Formation. This unit consists of interbedded red sandstone, siltstone, and shale with greenish-gray to red silty and sandy limestone.

The Devonian Frog Mountain Sandstone consists of sandstone and quartzitic sandstone with shale interbeds, dolomudstone, and glauconitic limestone (Osborne et al., 1988). This unit locally occurs in the western portion of Pelham Range.

The Mississippian Fort Payne Chert and the Maury Formation overlie the Frog Mountain Sandstone and are composed of dark to light gray limestone with abundant chert nodules and greenish-gray to grayish-red phosphatic shale, with increasing amounts of calcareous chert toward the upper portion of the formation (Osborne and Szabo, 1984). These units occur in the northwestern portion of Pelham Range. Overlying the Fort Payne Chert is the Floyd Shale, also of Mississippian age, which consists of thin-bedded, fissile, brown to black shale with thin intercalated limestone layers and interbedded sandstone. Osborne and Szabo (1984) reassigned the Floyd Shale, which was mapped by Warman and Causey (1962) on the Main Post of FTMC, to the Ordovician Athens Shale based on fossil data.

The Pennsylvanian Parkwood Formation overlies the Floyd Shale and consists of a medium to dark gray, silty, clay shale and mudstone with interbedded light to medium gray, very fine to fine grained, argillaceous, micaceous sandstone. Locally the Parkwood Formation also contains beds of medium to dark gray argillaceous, bioclastic to cherty limestone and beds of clayey coal up to a few inches thick (Raymond et al., 1988). The Parkwood Formation in Calhoun County is generally found within a structurally complex area known as the Coosa deformed belt. In the deformed belt, the Parkwood Formation and Floyd Shale are mapped as undifferentiated because their lithologic similarity and significant deformation make it impractical to map the contact (Thomas and Drahovzal, 1974; Osborne et al., 1988). The undifferentiated Parkwood Formation and Floyd Shale are found throughout the western quarter of Pelham Range.

The Jacksonville thrust fault is the most significant structural geologic feature in the vicinity of the Main Post of FTMC, both for its role in determining the stratigraphic relationships in the area and for its contribution to regional water supplies. The trace of the fault extends northeastward for approximately 39 miles between Bynum, Alabama, and Piedmont, Alabama. The fault is interpreted as a major splay of the Pell City fault (Osborne and Szabo, 1984). The Ordovician sequence that makes up the Eden thrust sheet is exposed at FTMC through an eroded window, or fenster, in the overlying thrust sheet. Rocks within the window display complex folding, with the folds being overturned and tight to isoclinal. The carbonates and shales locally exhibit well-developed cleavage (Osborne and Szabo, 1984). The FTMC window is framed on the northwest by the Rome Formation; north by the Conasauga Formation; northeast, east, and southwest by the Shady Dolomite; and southeast and southwest by the Chilhowee Group (Osborne et al., 1997). Two small klippen of the Shady Dolomite, bounded by the Jacksonville fault, have been recognized adjacent to the Pell City fault at the FTMC window (Osborne et al., 1997).

The Pell City fault serves as a fault contact between the bedrock within the FTMC window and the Rome and Conasauga Formations. The trace of the Pell City fault is also exposed approximately nine miles west of the FTMC window on Pelham Range, where it traverses northeast to southwest across the western quarter of Pelham Range. Here, the trace of the Pell City fault marks the boundary between the Pell City thrust sheet and the Coosa deformed belt.

The eastern three-quarters of Pelham Range is located within the Pell City thrust sheet, while the remaining western quarter of Pelham is located within the Coosa deformed belt. The Pell City thrust sheet, a large-scale thrust sheet containing Cambrian and Ordovician rocks, is relatively less structurally complex than the Coosa deformed belt (Thomas and Neathery, 1982). The Pell

City thrust sheet is exposed between the traces of the Jacksonville and Pell City faults along the western boundary of the FTMC window and along the trace of the Pell City fault on Pelham Range (Thomas and Neathery, 1982; Osborne et al., 1988). The Coosa deformed belt is a narrow (approximately 5 to 20 miles wide) northeast-to-southwest-trending linear zone of complex structure (approximately 90 miles in length) consisting mainly of thin imbricate thrust slices. The structure within these imbricate thrust slices is often internally complicated by small-scale folding and additional thrust faults (Thomas and Drahovzal, 1974).

3.6.2 Site-Specific Geology

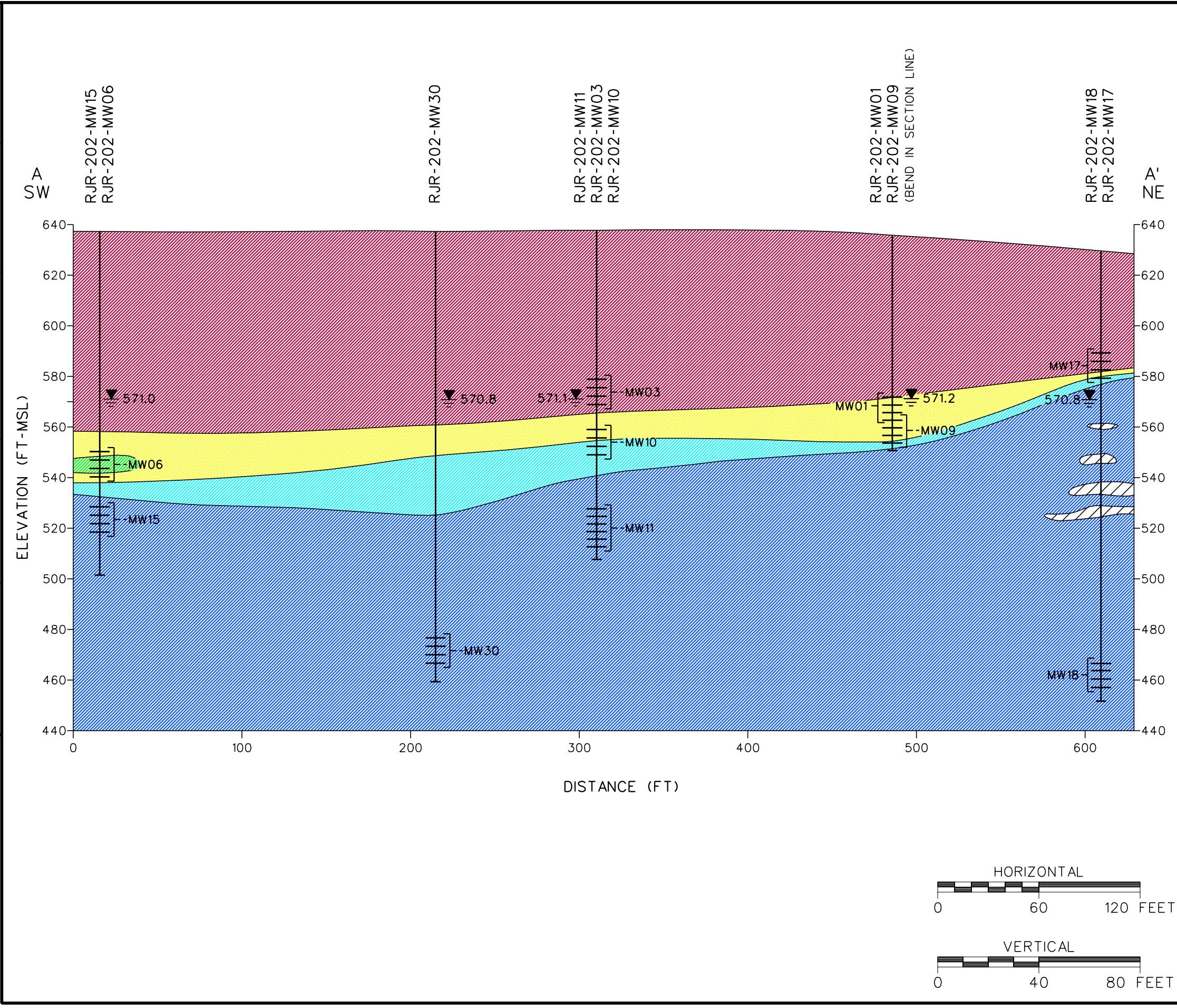
The geologic conditions at Range J, Parcel 202(7), were assessed using monitoring well and soil boring lithologic logs prepared by SAIC and Shaw during the supplemental RIs. Geologic cross sections showing the site geology are presented on Figures 3-3 and 3-4, and their locations are shown on Figure 3-5. The sequence encountered consists of an upper 60- to 90-foot-thick interval of residuum overlying fractured, vuggy dolomite.

In general, the residuum at Range J, Parcel 202(7), is undifferentiated yellowish orange to brownish orange clayey-sand to sandy-clay with abundant white to light brownish-yellow chert fragments from land surface to approximately 60 to 90 feet bgs. The residuum thickness along cross-section A-A' (Figure 3-3) decreases from the southwest to the northeast. On cross-section B-B' (Figure 3-4), the residuum thickness is almost uniform, with a very slight reduction in thickness towards the southeast. At monitoring well RJR-202-MW22, there is a decrease in the thickness of the residuum that coincides with an apparent bedrock high.

The boundary between the residuum and bedrock is transitional and consists of an interval between 60 and 90 feet bgs described as light gray cherty, sandy, weathered dolomite. This transitional zone represents weathered bedrock that has not decomposed to the extent to be termed residuum.

Osborne and Szabo (1984) map the bedrock at Range J as part of the Lower Ordovician to Upper Cambrian undifferentiated Knox Group. During the drilling of monitoring wells, hard, moderately weathered, highly fractured, light gray, finely crystalline, vuggy dolomite, typical of the Knox Group, was encountered underlying the residuum. In places the dolomite is described as sandy and cherty. The top of the bedrock approximately corresponds to present-day topography, with a bedrock high trending northeast-southwest approximately 100 feet to the northwest of the present topographic high. Cross-section A-A' (Figure 3-3) terminates on top of

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DRAWN BY: D. BOMAR
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ENGR, CHECK, BY: S. MORAN
INITIATOR: D. ALLAN
PROJ. MGR.: J. YACOB
DWG. NO.: \774645es.893
PROJ. NO.: 774645



LEGEND

SCREEN INTERVAL

WATER TABLE

570.8 GROUNDWATER ELEVATION (FT MSL) (OCTOBER 2, 2001)

VOIDS

SAND

CLAY

SILT AND CLAY

WEATHERED DOLOMITE

DOLOMITE

NOTE:

1. GROUNDWATER ELEVATIONS ARE AVERAGED BETWEEN ADJACENT WELLS. SEE TABLE 2-5 FOR INDIVIDUAL ELEVATIONS.

FIGURE 3-3
GEOLOGIC CROSS-SECTION A-A'
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

Shaw Shaw Environmental, Inc.

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VERTICAL
0 40 80 FEET

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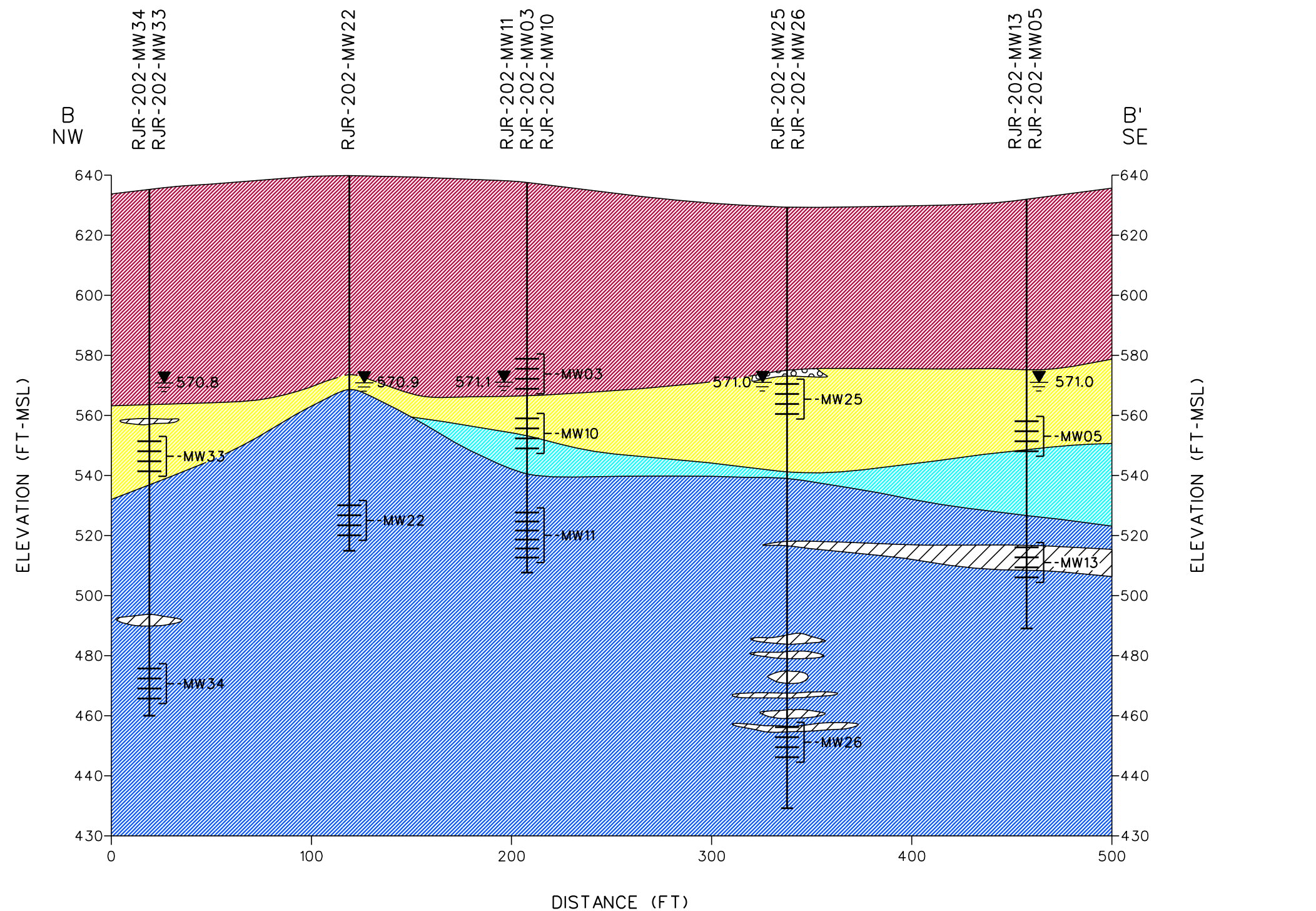
STARTING DATE: 02/26/02
DRAWN BY: D. BOMAR

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ENGR, CHECK, BY: S. MORAN

INITIATOR: D. ALLAN
PROJ. MGR.: J. YACOB

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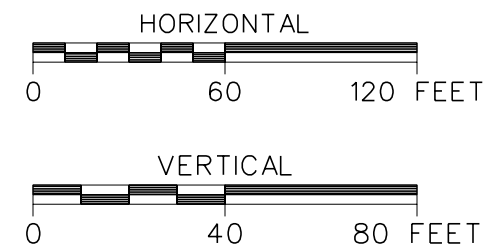
LEGEND

- SCREEN INTERVAL
- WATER TABLE
- 570.8 GROUNDWATER ELEVATION (FT MSL) (OCTOBER 2, 2001)
- VOIDS
- GRAVEL
- SAND
- SILT AND CLAY
- WEATHERED DOLOMITE
- DOLOMITE

NOTE:

- GROUNDWATER ELEVATIONS ARE AVERAGED BETWEEN ADJACENT WELLS. SEE TABLE 2-5 FOR INDIVIDUAL ELEVATIONS.

FIGURE 3-4
GEOLOGIC CROSS-SECTION B-B'
RANGE J - PELHAM RANGE
PARCEL 202(7)



U. S. ARMY CORPS OF ENGINEERS
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FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

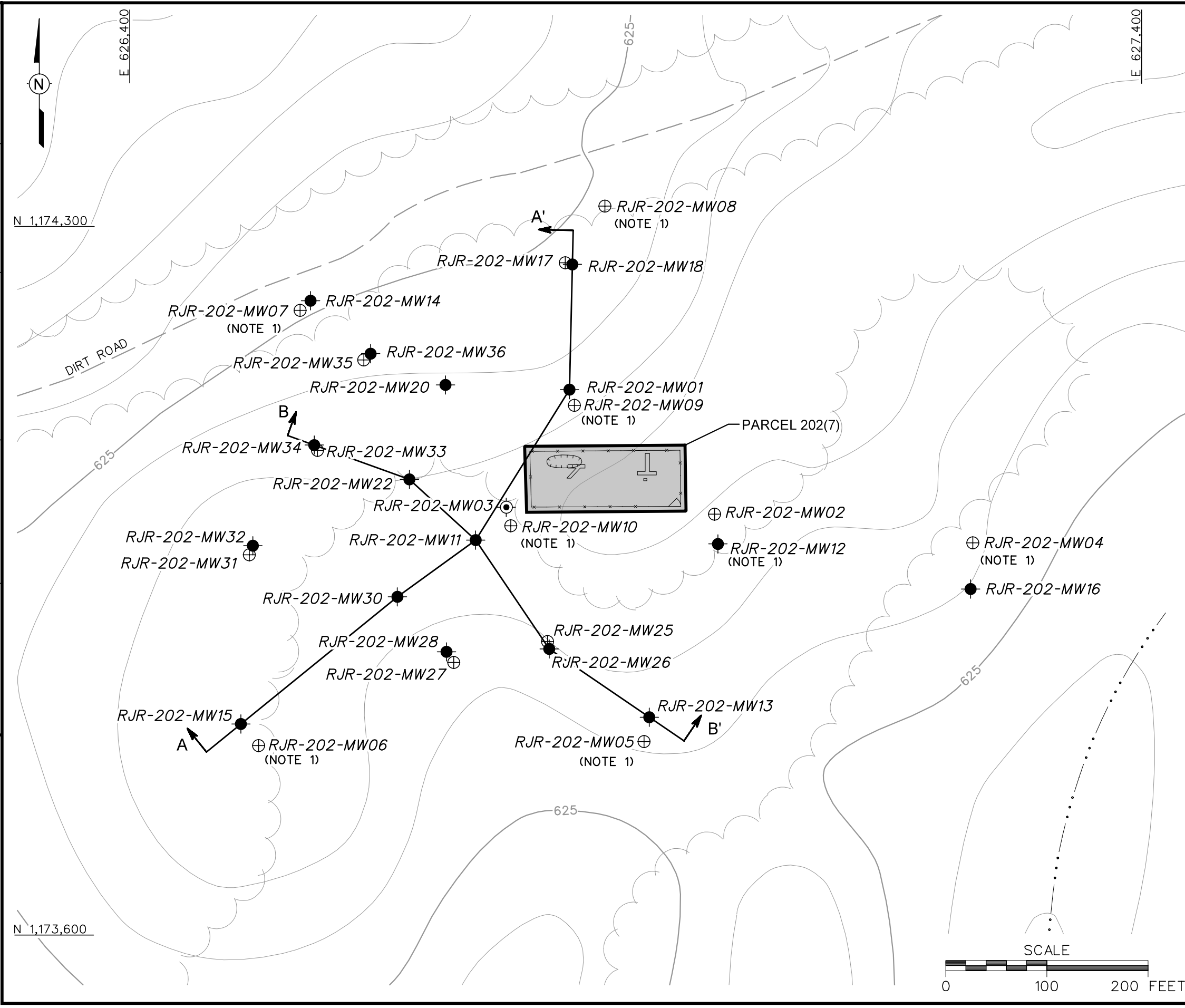
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DRAFT. CHK. BY:
ENGR. CHK. BY: S. MORAN

INITIATOR: D. ALLAN
PROJ. MGR.: J. YACOB

DWG. NO.: ...774645es.889
PROJ. NO.: 774645



LEGEND

- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
- TREES / TREELINE
- PARCEL BOUNDARY
- FENCE
- FORMER SOIL / DRUM DISPOSAL PIT
- FORMER TRENCH EXCAVATION
- RESIDUUM/BEDROCK MONITORING WELL LOCATION
- RESIDUUM MONITORING WELL LOCATION
- BEDROCK MONITORING WELL LOCATION
- CROSS SECTION LOCATION

NOTE:

1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.

FIGURE 3-5
CROSS SECTION LOCATION MAP
RANGE J - PELHAM RANGE
PARCEL 202(7)

this bedrock high to the north; cross-section B-B' (Figure 3-4) cuts across this bedrock high at approximately the location of monitoring well RJR-202-MW22.

Evidence of solution porosity of the dolomite in the form of voids was encountered in the bedrock during drilling. Voids were present in seven wells (RJR-202-MW18, RJR-202-MW22, RJR-202-MW26, RJR-202-MW28, RJR-202-MW33, RJR-202-MW34, and RJR-202-MW36); most of the voids were discovered when drilling tools dropped during drilling. Some of the voids were noted to be filled with silt and sand. The size of the voids ranges between 0.4 foot at RJR-202-MW26 to 30.5 feet at RJR-202-MW28. The monitoring wells that contain voids are concentrated within the central portion of the study area.

There appears to be a considerable degree of lateral connectivity within carbonate lithologies of the Knox Group. This appears to be especially true in the northeast part of the study area. During air-rotary drilling operations it was noted that the amount of compressed air communicating between adjacent wells was greatest in the northeast part of the study area.

No faults have been mapped intersecting this site. Faults within the area of Pelham Range trend northeast to southwest and are thrust faults, with the hanging wall having moved to the northwest.

3.7 Surface Water Hydrology

Regional surface water hydrology in the vicinity of FTMC and Range J site-specific surface water hydrology are discussed in the following sections.

3.7.1 Regional Surface Water Hydrology

The Choccolocco Mountains, located in the eastern portion of the Main Post, form a major surface water divide. East of this divide, the reservation consists of a relatively narrow strip called Choccolocco Corridor, which extends approximately 3.5 to 4 miles from the mountains across the floodplain of Choccolocco Creek, to the base of Rattlesnake Mountain. Choccolocco Creek and its tributaries drain this portion of FTMC and flow southward to the Coosa River.

The entire central portion of FTMC west of the drainage divide is drained by three major creeks and their tributaries. South Branch of Cane Creek receives runoff from the south-central portion, then joins Cane Creek before leaving the reservation on the western boundary. Cane Creek receives surface runoff from the central section. The north-central section of the Main Post is drained by Cave Creek, which leaves the post on the northwestern boundary. Remount Creek,

which drains the west-central portion of the Main post, flows north from Lake Yahou and joins Cane Creek in the northwest area of the post. Other surface water features on the Main Post include Lake Yahou (13.5 acres), Reilly Lake (8.5 acres), Cappington Ridge (0.3 acres), Duck Pond (0.5 acre), and an aqueduct. Surface drainage is collected in small, independent networks that drain areas varying from 20 to 60 acres (SAIC, 2000).

The Cane/Cave Creek watershed is among six major watersheds in Calhoun County. Cane Creek, with its tributaries (Remount, South Branch, and Ingram Creeks), originates on FTMC. These creek systems originate in the Choccolocco Mountains on the eastern boundary of the installation and flow west through Main Post. They are fed by springs originating in underlying limestone strata. Cane Creek also passes through the entire length of Pelham Range, but its size and volume are greatly increased by the time it reaches this area. Cane Creek eventually discharges into the Coosa River, approximately 10 miles west of Pelham Range (SAIC, 2000).

Cane Creek, which flows westward from the Main Post across the center of Pelham Range, and its tributaries drain almost all of Pelham Range. Drainage entering the range from the south originates in the Anniston Army Depot, which adjoins Pelham Range to the south (Figure 3-6). One drainage way located in the southwestern area of Pelham Range flows in a northerly direction and empties into a large topographic low (Battle Drill Area). Cane Creek traverses this low area some 800 yards to the north. All water collected in the low eventually drains into Cane Creek. Other surface water features on Pelham Range include Lake Contreras (27 acres), Cane Creek Lake (7.5 acres), Willet Springs (0.8 acres), and Blue Hole (0.2 acres). All drainage from FTMC and Pelham Range ultimately empties into the Coosa River. Floodplains up to 2,500 feet wide traverse this sector and slope toward the center of the range. The wide floodplains are absent in the southern portion of the range (SAIC, 2000).

Most surface water bodies are fed at least in part by freshwater springs. Freshwater springs occur abundantly on installation lands, often appearing along the trace of thrust faults. Karst features, including developed caves and sinkholes, have been identified in the FTMC area; sinkholes especially have been identified on Pelham Range, although no sinkholes have been identified in the vicinity of Range J.

Freshwater marshes located along Cane Creek are mostly limited to the cumulatively larger downstream watershed of Pelham Range. The drainage area of Cane Creek on Pelham Range has an abundance of riparian flora and fauna. Marsh areas include the 75-acre marsh beginning to the right of the Gate 3 entrance, a 7-acre area to the right of Cane Creek on the Battle Drill

Figure 3-6

Surface Water Hydrology and Drainage Basins, Pelham Range

Range J, Parcel 202(7)
Fort McClellan, Alabama

Legend

- Pelham Range Boundary
- Roads
- Major Streams
- Surface Water Flow Direction
- Lakes/Ponds
- Cane Creek Drainage Basin
- Tallasseeatchee Creek Drainage Basin
- Choccolocco Creek Drainage Basin

4000 0 4000 Feet
NAD83 State Plane Coordinates



Shaw Shaw Environmental, Inc.



U.S. Army Corps
of Engineers
Mobile District

Contract No. DACA21-96-D-0018

Drainage Basin Data From: Geological Survey of Alabama
USDA Natural Resources Conservation, 1997,
11-digit Hydrologic Units for Alabama:
GSA Digital Geospatial Data Series huc11,
Geological Survey of Alabama, Tuscaloosa, Alabama.

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Area, a seasonal marsh area surrounding Blue Hole Pond, an area south of the impact area road, and a large area from Gate 13 to the Battle Drill Area where flats occur.

3.7.2 Site-Specific Surface Water Hydrology

Surface water draining from the area of Range J flows into one of two unnamed creeks, both flowing to the southwest into Cane Creek. One creek is located approximately 500 feet south-southwest of the site and is intermittent (Figure 3-2). The other creek is located approximately 1,000 feet north-northwest of the site and is perennial. It is also possible that surface water from Range J flows directly into Cane Creek, which is located approximately 3,000 feet south of the site. After connecting with Cane Creek, the water will ultimately flow to the west into the Coosa River.

3.8 Hydrogeology

Regional hydrogeology in the vicinity of FTMC and Range J site-specific hydrogeology are discussed in the following sections.

3.8.1 Regional Hydrogeology

The hydrogeology of Calhoun County has been investigated by the Geologic Survey of Alabama (GSA) (Moser and DeJarnette, 1992) and by the U.S. Geological Survey (USGS) in cooperation with the GSA (Warman et al., 1960) and ADEM (Planert and Pritchette, 1989). Groundwater in the vicinity of FTMC occurs in residuum derived from bedrock decomposition, within fractured bedrock, along fault zones, and from the development of karst frameworks. Groundwater flow may be estimated to be toward major surface water features. However, because of the impacts of differential weathering and variable fracturing and the potential for conduit flow development, the use of surface topography as an indicator of groundwater flow direction must be exercised with caution in the area. Areas with well-developed residuum horizons may subtly reflect the surface topography, but the groundwater flow direction also may exhibit the influence of pre-existing structural fabrics or the presence of perched water horizons on unweathered ledges or impermeable clay lenses. Because of the various geologic factors described above, the extension of groundwater elevation contours over distances on the size and scale of FTMC is not practical without closely spaced control points (SAIC, 2000).

Precipitation and subsequent infiltration provide recharge to the groundwater flow system in the region. The main recharge areas for the aquifers in Calhoun County are located in the valleys. The ridges generally consist of sandstones, quartzite, and slate, which are resistant to weathering, relatively unaffected by faulting, and therefore relatively impermeable. The ridges have steep

slopes and thin to no soil cover, which enhances runoff to the edges of the valleys (Planert and Pritchette, 1989).

The thrust fault zones typical of the county form large storage reservoirs for groundwater. Points of discharge occur as springs, effluent streams, and lakes. Coldwater Spring is the largest spring in the State of Alabama, with a discharge of approximately 32 million gallons per day. This spring is the main source of water for the Anniston Water Department, from which FTMC buys its water. The spring is located approximately 5 miles southwest of Anniston and discharges from the brecciated zone of the Jacksonville Fault (Warman et al., 1960).

Shallow groundwater on FTMC occurs principally in the residuum developed from Cambrian sedimentary and carbonate bedrock units of the Weisner Formation and the Shady Dolomite and locally in Lower Ordovician carbonates. The residuum may yield adequate groundwater for domestic and livestock needs but may go dry during prolonged dry weather. Groundwater within the residuum serves as a recharge reservoir for the underlying bedrock aquifers. Bedrock permeability is locally enhanced by fracture zones associated with thrust faults and by the development of solution (karst) features.

Two major aquifers were identified by Planert and Pritchette (1989), the Knox-Shady and Tuscumbia-Fort Payne aquifers. The continuity of the aquifers has been disrupted by the complex geologic structure of the region, such that each major aquifer occurs repeatedly in different areas. The Knox-Shady aquifer group occurs over most of Calhoun County and is the main source of groundwater in the county. It consists of Cambrian- and Ordovician-aged quartzite and carbonates. The Conasauga Formation is the most utilized unit of the Knox-Shady aquifer, with twice as many wells drilled as any other unit (Moser and DeJarnette, 1992). However, there are no water supply wells within a 1-mile radius of Range J.

The Tuscumbia-Fort Payne aquifer occurs in the extreme northwestern portion of the county. This aquifer consists of Mississippian-age carbonates and shales. Because of its limited outcrops in the recharge area and the rugged terrain of the outcrop area, the Tuscumbia-Fort Payne aquifer is not considered a major groundwater supply in Calhoun County (Moser and DeJarnette, 1992). However, it is an important source of groundwater in counties to the west (Planert and Pritchette, 1989).

Regional groundwater flow in the bedrock was approximated for the FTMC vicinity by the USGS (Scott et al., 1987). Regional groundwater elevation ranged from 800 feet above msl on

the main base to about 600 feet above msl to the west on Pelham Range, based on water depths in wells completed across multiple formations. Groundwater elevation contours suggest that regional groundwater flow is from the Main Post to the northwest; a similar direction of regional groundwater flow is expected to occur across Pelham Range. There is not enough groundwater data to support this interpretation. Scott et al. (1987) concluded that the groundwater surface broadly coincides with the surface topography and that the regional aquifers are hydraulically connected. Groundwater flow on a local scale may be more complex and may be affected by geological structures such as the shallow thrust faults, rock fracture systems, and karst development in soluble formations.

Shallow groundwater occurs in weathered residuum derived from the bedrock and thin sediment deposits that are very similar to the decomposed rock. The shallow groundwater more closely follows the local topography.

3.8.2 Site-Specific Hydrogeology

3.8.2.1 Groundwater Flow

Groundwater elevations at Range J were calculated by measuring the depth to groundwater relative to top-of-casing elevations in the monitoring wells installed at the site. Groundwater elevations were measured on June 13 and October 2, 2001; all wells contained water except RJR-202-MW17. Subsequent attempts to collect samples and water levels from RJR-202-MW17 were unsuccessful. Monitoring well construction and groundwater elevation data are presented in Tables 2-4 and 2-5, respectively. Groundwater elevation maps for both residuum and bedrock aquifers are provided on Figures 3-7 through 3-10. The two groundwater elevation measuring events were intended to capture data from an above-average period of precipitation (June) and from a below-average period of precipitation (October) (Figure 3-1).

Based on the groundwater elevation data presented on Figures 3-7 and 3-9, groundwater flow within the residuum conforms in general to surface topography. Both the June and October data sets show an overall westward flow direction. The northwest and southeast flow components reflect the northeast-southwest trending topographic high that transects the site. The bedrock data (Figures 3-8 and 3-10) also support a westward flow direction within the deeper Knox interval. Flow maps for the residuum and bedrock for the high rainfall period in June indicate a broad and generalized flow pattern, probably reflecting the rapid recharge occurring at this time.

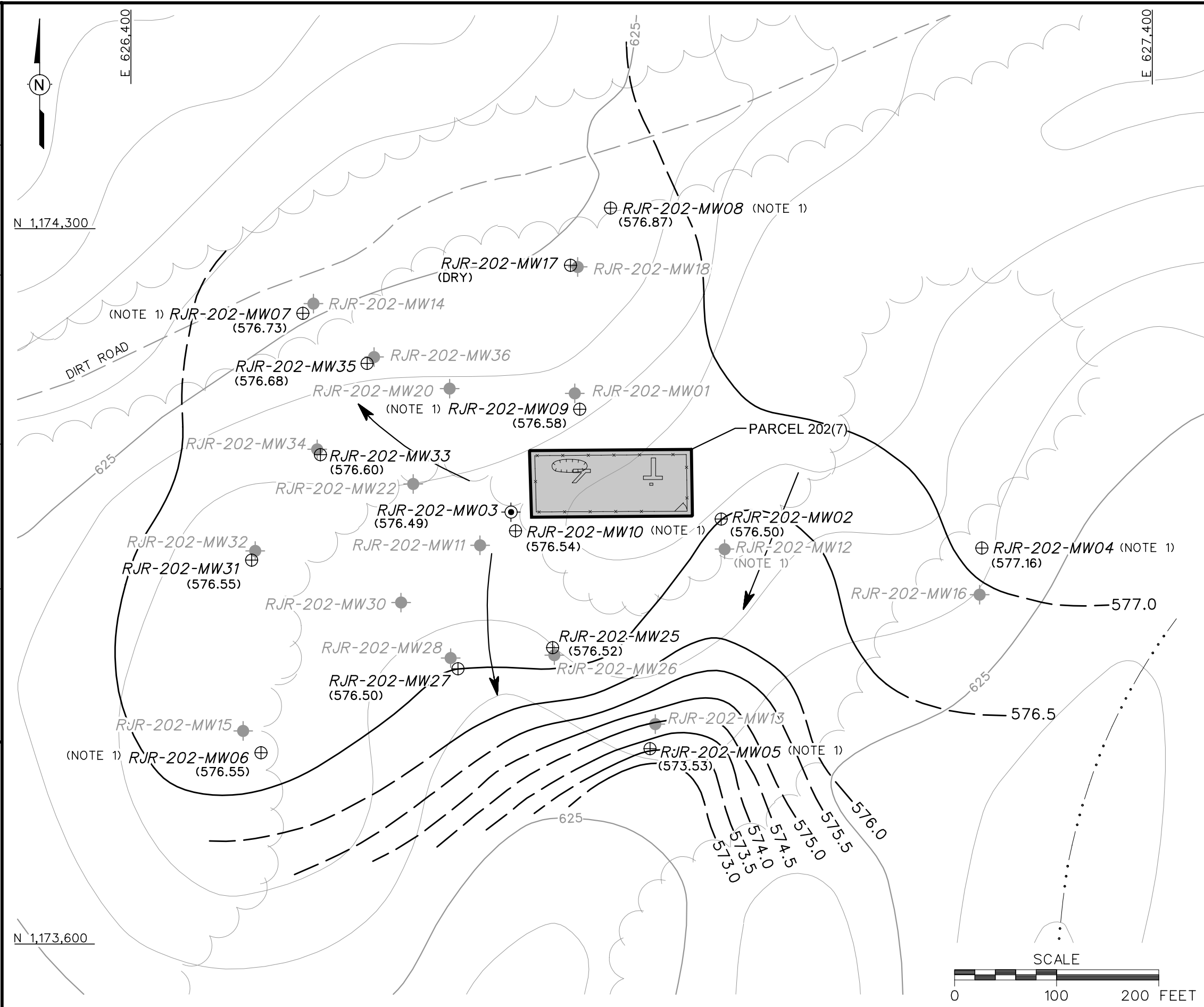
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DATE LAST REV.:
DRAWN BY: D. BOWAR

STARTING DATE: 02/20/02

ENG. CHK. BY: S. MORAN
PROJ. MGR.: J. YACOB

INITIATOR: D. ALLAN
DWG. NO.: ...774645es.873
PROJ. NO.: 774645



- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)
 - GROUNDWATER ELEVATION (FT MSL) (JUNE 13, 2001)
 - GROUNDWATER FLOW DIRECTION
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION

NOTE:

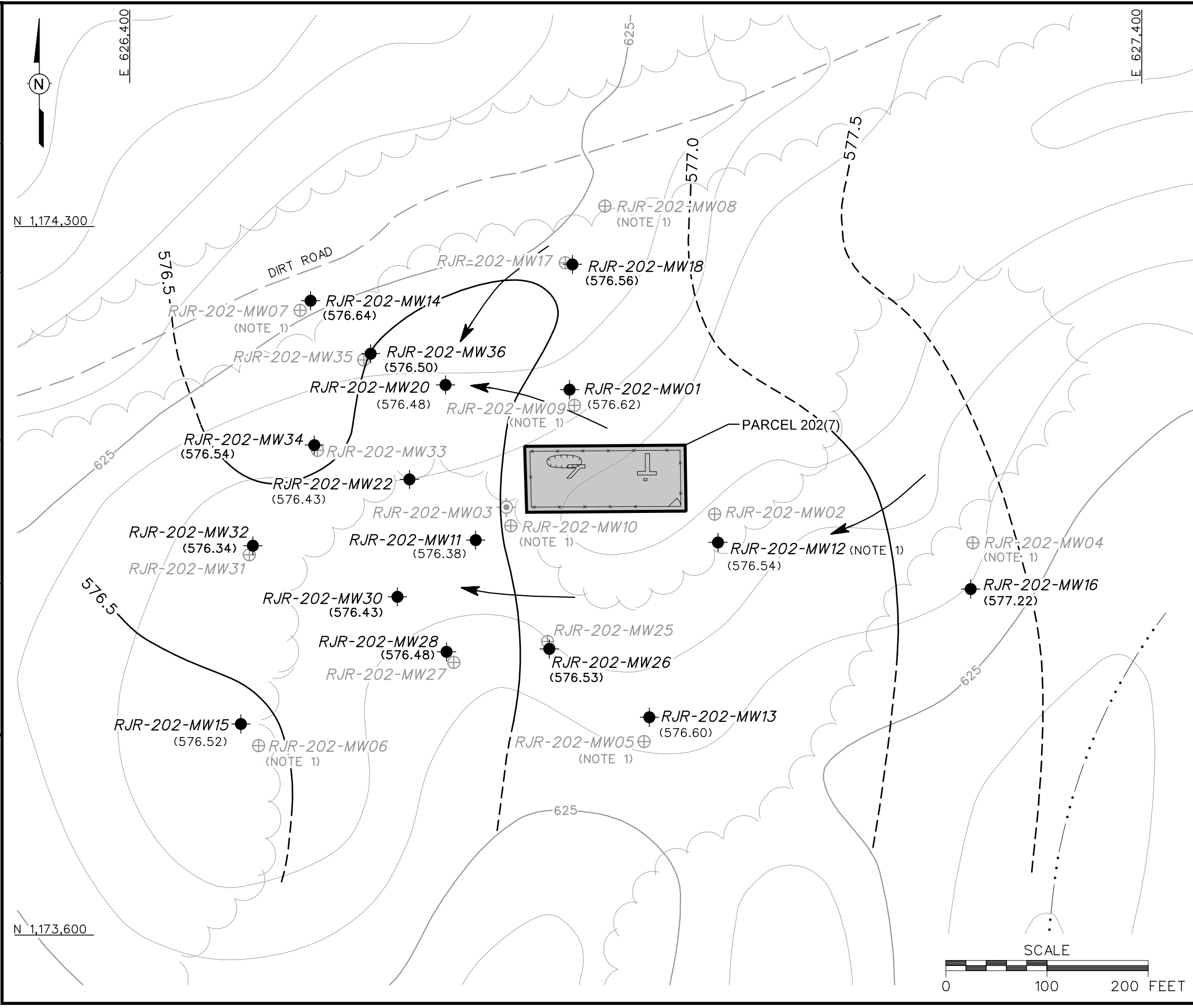
1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.

FIGURE 3-7
GROUNDWATER ELEVATION MAP
RESIDUUM MONITORING WELLS
JUNE 13, 2001
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

Shaw Shaw Environmental, Inc.

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PROJ. MGR.:J. YACOB
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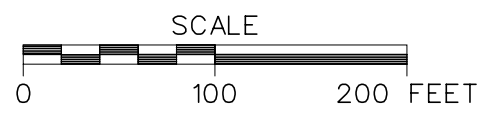
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- GROUNDWATER ELEVATION CONTOUR
(DASHED WHERE INFERRED)
- (577.00) GROUNDWATER ELEVATION (FT MSL)
(JUNE 13, 2001)
- GROUNDWATER FLOW DIRECTION
- TREES / TREELINE
- PARCEL BOUNDARY
- FENCE
- FORMER SOIL / DRUM DISPOSAL PIT
- FORMER TRENCH EXCAVATION
- RESIDUUM/BEDROCK MONITORING
WELL LOCATION
- RESIDUUM MONITORING WELL LOCATION
- BEDROCK MONITORING WELL LOCATION

NOTE:

1. SURFACE AND SUBSURFACE SOIL SAMPLES
ALSO COLLECTED AT THIS LOCATION.

FIGURE 3-8
GROUNDWATER ELEVATION MAP
BEDROCK MONITORING WELLS
JUNE 13, 2001
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018



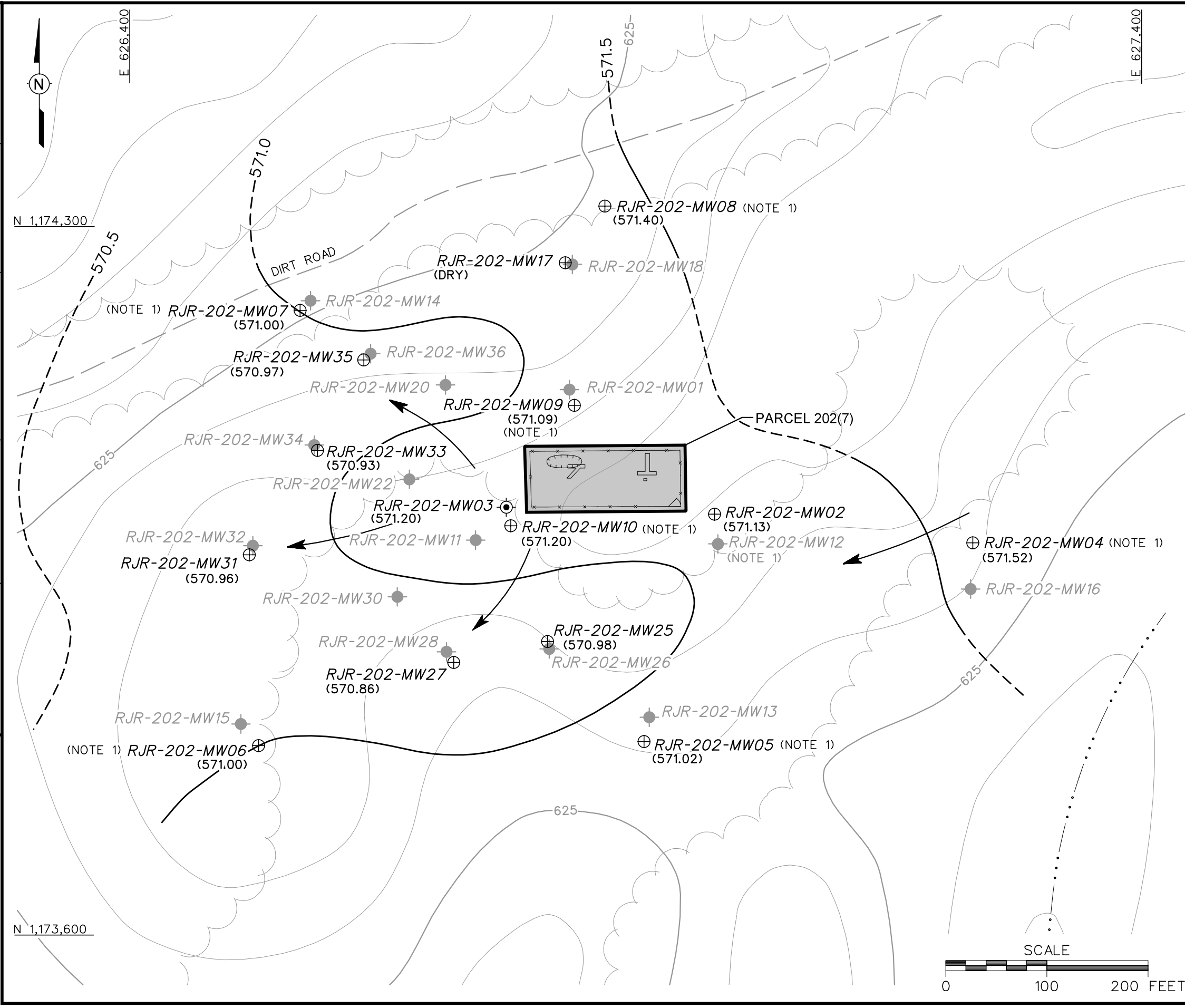
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INITIATOR: D. ALLAN
PROJ. MGR.: J. YACOB

DWG. NO.: ... \774645es.876
PROJ. NO.: 774645



- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)
 - GROUNDWATER ELEVATION (FT MSL) (OCTOBER 2, 2001)
 - GROUNDWATER FLOW DIRECTION
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION

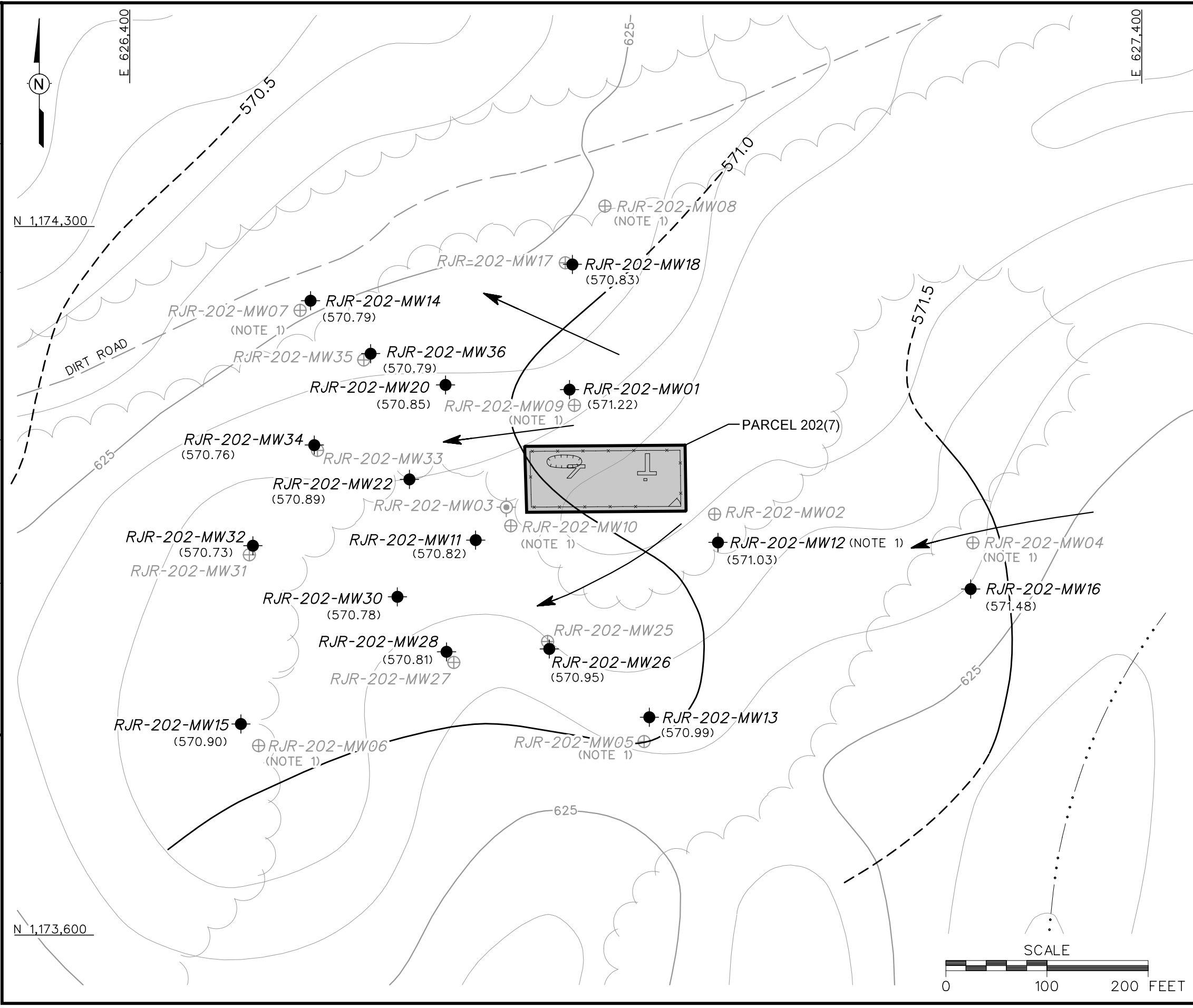
NOTE:

1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.

FIGURE 3-9
GROUNDWATER ELEVATION MAP
RESIDUUM MONITORING WELLS
OCTOBER 2, 2001
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

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PROJ. MGR.: J. YACOB
INITIATOR: D. ALLAN
DWG. NO.: ...774645es.874
PROJ. NO.: 774645



- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)
 - GROUNDWATER ELEVATION (FT MSL) (OCTOBER 2, 2001)
 - GROUNDWATER FLOW DIRECTION
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION

NOTE:

1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.

FIGURE 3-10
GROUNDWATER ELEVATION MAP
BEDROCK MONITORING WELLS
OCTOBER 2, 2001
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

Shaw Shaw Environmental, Inc.

3.8.2.2 Aquifer Characteristics

The horizontal hydraulic gradient in both the residuum and bedrock aquifers is very low, with only approximately a foot or less of elevation difference across the area investigated. For the high precipitation period in June, in both residuum and bedrock intervals, flow is too dispersed to obtain a useful horizontal gradient. For October, average horizontal gradients of 0.001561 foot per foot (ft/ft) (for residuum) and 0.00243 ft/ft (for bedrock) were calculated (Table 3-1).

Calculations of the vertical hydraulic gradients between adjacent bedrock and residuum wells are presented in Table 3-2. Only wells within the central area of contamination and only October 2001 groundwater elevations were used. Gradients calculated are relatively small (less than 0.01); all but one well cluster (RJR-202-MW09/RJR-202-MW01) indicate a downward vertical flow between the residuum and bedrock aquifers, supporting connectivity.

Hydraulic conductivity values calculated from both rising and falling head slug tests conducted at the site on eight wells are presented in Table 3-3. The slug test data and methodology are included in Appendix E. Hydraulic conductivity values for residuum wells ranged from 1.04 feet per day (ft/day) (rising test) to 15.5 ft/day (falling test), with a geometric mean of 3.04 ft/day. For the deeper bedrock wells, conductivity values ranged from 4.02 ft/day (rising test) to 9.35 ft/day (falling test), with a geometric mean of 6.52 ft/day. Three wells screened in the transitional zone between the residuum and bedrock were also slug tested and gave a range of hydraulic conductivity values from 0.161 ft/day (falling test) to 7.59 ft/day (rising test), with a geometric mean of 1.66 ft/day.

The average linear velocity was calculated for groundwater flow in the residuum and bedrock. Geometric mean hydraulic conductivity values and average horizontal hydraulic gradients presented in Tables 3-1 and 3-3 were used. Effective porosities were estimated at 30 percent for the residuum and 15 percent for the bedrock. Based on these parameters, groundwater flow velocities of 0.01581 ft/day for the residuum and 0.10562 ft/day for the bedrock were calculated.

Table 3-1

**Horizontal Hydraulic Gradients
Range J, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

Zone	Upgradient Well	GW Elevation Oct 01 (ft above msl)	Downgradient Well	GW Elevation Oct 01 (ft above msl)	Measured Distance (ft)	Elevation Difference (ft)	Horizontal Gradient
Residuum	RJR-202-MW03	571.20	RJR-202-MW35	570.97	200	0.23	0.00115
	RJR-202-MW03	571.20	RJR-202-MW33	570.93	195	0.27	0.00139
	RJR-202-MW03	571.20	RJR-202-MW27	570.86	160	0.34	0.00213
Average							0.00156
Bedrock	RJR-202-MW01	571.22	RJR-202-MW20	570.85	120	0.37	0.00308
	RJR-202-MW01	571.22	RJR-202-MW34	570.76	260	0.46	0.00177
Average							0.00243

ft - Feet.

GW - Groundwater.

msl - Mean sea level.

Table 3-2

**Vertical Hydraulic Gradients
Range J, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

Well Cluster ID	Midpoint of Screen (ft amsl)	GW Elevation (Oct 01) (ft amsl)	dH	dL	Vertical Gradient (I)
RJR-202-MW31	561.6	570.96	0.23	91.7	0.0025
RJR-202-MW32	469.9	570.73			
RJR-202-MW09	558.7	571.09	-0.13	8.6	-0.0151
RJR-202-MW01	567.3	571.22			
RJR-202-MW35	563	570.97	0.18	91.8	0.0020
RJR-202-MW36	471.2	570.79			
RJR-202-MW33	546.4	570.93	0.17	75.7	0.0022
RJR-202-MW34	470.7	570.76			
RJR-202-MW27	548.4	570.86	0.05	68	0.0007
RJR-202-MW28	480.4	570.81			
RJR-202-MW07	566.2	571	0.21	94.8	0.0022
RJR-202-MW14	471.4	570.79			
RJR-202-MW25	565.5	570.98	0.03	114.3	0.0003
RJR-202-MW26	451.2	570.95			

I, Vertical hydraulic gradient = dH / dL , + if downward gradient, - if upward gradient

dH = head shallower well - head deeper well

dL = vertical distance between mid-point of well screens.

GW = Groundwater.

ft amsl = Feet above mean sea level.

Table 3-3

**Summary of Hydraulic Conductivities
Range J - Pelham Range, Parcel 202 (7)
Fort McClellan, Calhoun County, Alabama**

Well No.	Date Tested	Saturated Aquifer Thickness (Assumed)	Test Type	Transmissivities T (ft ² /day)	Hydraulic Conductivities K (ft/min)	Hydraulic Conductivities K (cm/sec)	Hydraulic Conductivities K (ft/day)
Residuum							
RJR-202-MW03	5/1/1995	9.95	Rising	1.10E+01	7.66E-04	3.89E-04	1.10E+00
RJR-202-MW10	8/29/2001	23.90	Falling	3.63E+01	1.09E-03	5.54E-04	1.57E+00
			Rising	2.49E+01	7.24E-04	3.68E-04	1.04E+00
RJR-202-MW27	8/30/2001	28.40	Falling	1.69E+02	1.08E-02	5.47E-03	1.55E+01
			Rising	2.65E+02	6.48E-03	3.29E-03	9.33E+00
Maximum				2.65E+02	1.08E-02	5.47E-03	1.55E+01
Minimum				1.10E+01	7.24E-04	3.68E-04	1.04E+00
Geometric Mean				5.36E+01	2.11E-03	1.07E-03	3.04E+00
Transition Zone							
RJR-202-MW11	8/30/2001	56.00	Falling	1.66E+02	2.06E-03	1.05E-03	2.97E+00
			Rising	1.99E+02	2.46E-03	1.25E-03	3.55E+00
RJR-202-MW15	8/30/2001	19.00	Falling	1.39E+02	5.09E-03	2.59E-03	7.32E+00
			Rising	1.44E+02	5.27E-03	2.68E-03	7.59E+00
RJR-202-MW22	8/29/2001	50.00	Falling	8.04E+00	1.12E-04	5.67E-05	1.61E-01
			Rising	1.11E+01	1.54E-04	7.82E-05	2.22E-01
Maximum				1.99E+02	5.27E-03	2.68E-03	7.59E+00
Minimum				8.04E+00	1.12E-04	5.67E-05	1.61E-01
Geometric Mean				6.24E+01	1.15E-03	5.86E-04	1.66E+00
Bedrock							
RJR-202-MW14	8/30/2001	111.30	Falling	7.18E+02	4.48E-03	2.28E-03	6.45E+00
			Rising	2.57E+02	2.79E-03	1.42E-03	4.02E+00
RJR-202-MW28	8/29/2001	109.90	Falling	1.03E+03	6.49E-03	3.30E-03	9.35E+00
			Rising	8.21E+02	5.19E-03	2.64E-03	7.47E+00
Maximum				1.03E+03	6.49E-03	3.30E-03	9.35E+00
Minimum				2.57E+02	2.79E-03	1.42E-03	4.02E+00
Geometric Mean				6.28E+02	4.53E-03	2.30E-03	6.52E+00

Notes: 1. Saturated Aquifer Thickness - For a confined Aquifer, this is the distance from the base of the upper confining unit to the top of the lower confining unit. For an unconfined aquifer, this is the distance from the water table to the top of the lower confining unit.

2. Analysis Method - Cooper, Bredehoeft, Papadopulos (1967) method is used for the well with confined aquifers response.

Bower and Rice (1976) method is used for the well with unconfined aquifers response.

ft²/day = Square feet per day.

ft/min = Feet per minute.

cm/sec = Centimeters per second.

ft/day = feet per day.

4.0 Nature and Extent of Contamination

4.1 Geophysical Survey Results

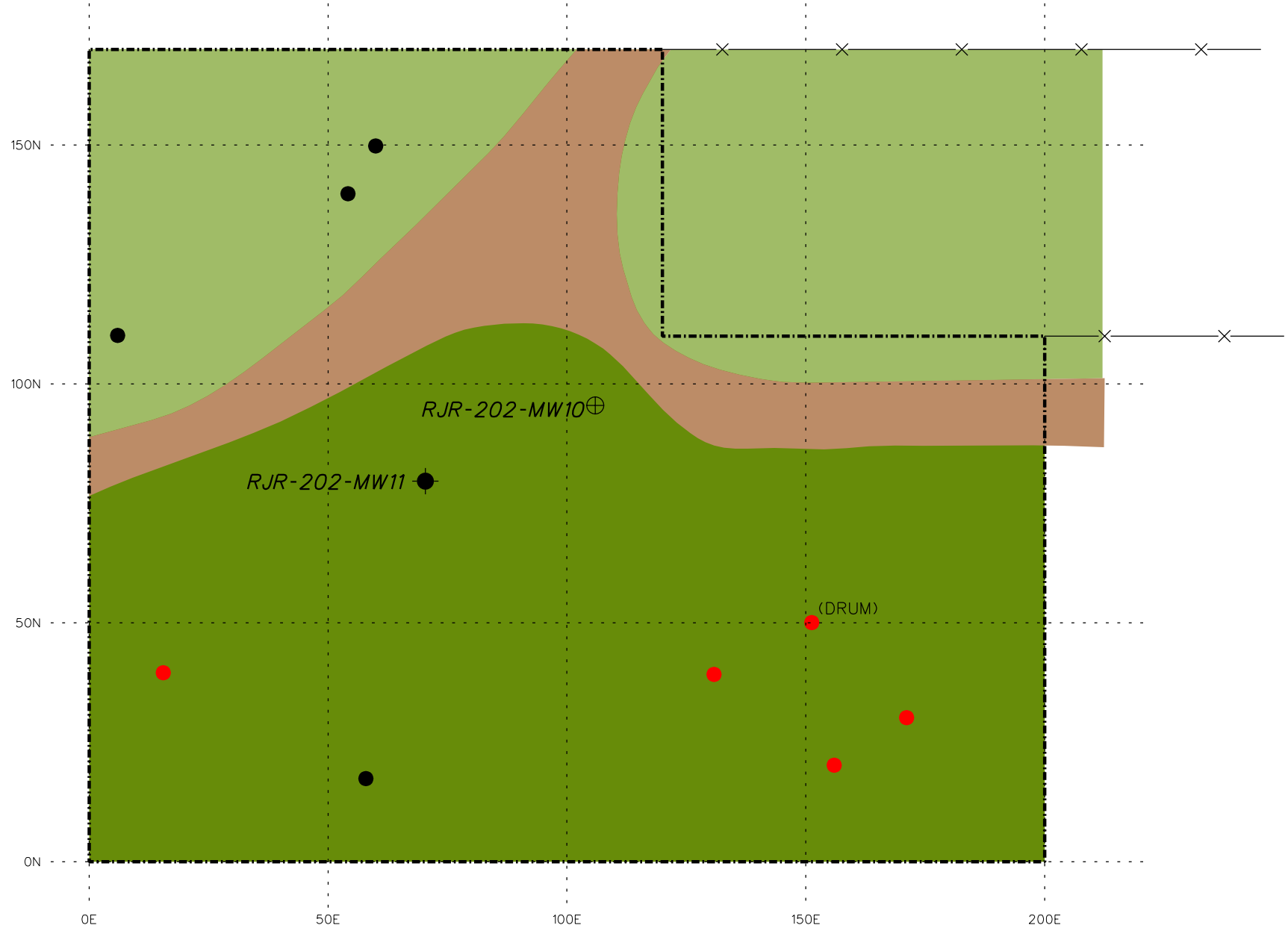
The geophysical survey results indicate that there are no geophysical anomalies that potentially represent buried drums at Range J, Parcel 202(7). Several discrete small EM61 anomalies were observed in the data. These anomalies are interpreted as low concentrations of buried non-ferrous metallic debris. The geophysical interpretation map of the site (Figure 4-1) shows these anomaly locations and contains detailed information on permanent site reference features to aid in relocating the anomalies and the survey area. The anomalies shown on the interpretation maps correspond to those shown in the magnetic and EM data contour maps presented in the geophysics report. A detailed discussion of the data interpretation is included in the interpretation chapter of the geophysics report (Appendix A).

4.2 Sources of Contamination

The source area of contamination in environmental media at Range J, Parcel 202(7), was initially thought to be a burial pit within the fenced area at the range. However, investigations within the fenced area by both SAIC and Shaw established that the fenced area was most likely not the source area. Other possible sources of contamination at Range J include two 55-gallon drums (one intact and one crushed) located south-southwest of the fenced area. Shaw collected a sample of unknown liquid from the intact drum and analyzed the sample for metals, VOCs, and SVOCs. However, the analytical results did not indicate the presence of organic solvents (e.g., carbon tetrachloride, 1,1,2,2-PCA, benzene, PCE, or TCE) in the intact drum (see Section 4.3.4). In light of the aforementioned information, the most likely source of soil and groundwater contamination at Range J was the direct discharge of decontamination agents to the ground incidental to training activities.

4.3 Summary of Analytical Results

The results of the chemical analysis of samples collected at Range J, Parcel 202(7), indicate that metals, VOCs, and SVOCs were detected in the various site media. Nitrate/nitrite and sulfate were also detected in groundwater. CWM breakdown products were not detected in site media. To evaluate the nature and extent of contamination at the site, the analytical results were compared to human health site-specific screening levels (SSSL), ecological screening values (ESV), and background screening values for FTMC. The SSSLs and ESVs were developed by Shaw as part of the human health and ecological risk evaluations associated with site investigations being performed under the BRAC Environmental Restoration Program at FTMC.



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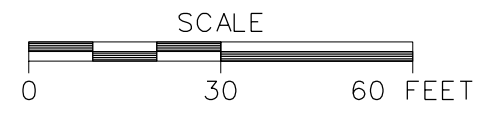
- GEOPHYSICAL SURVEY BOUNDARY
- FENCE
- GRASS
- WOODED AREA
- DIRT ROAD
- BURIED METAL
- SURFACE METAL
- RESIDUUM MONITORING WELL LOCATION
- BEDROCK MONITORING WELL LOCATION

NOTE:

1. FENCE AND WELL LOCATIONS DETERMINED FROM GEOPHYSICAL SURVEY.

FIGURE 4-1
GEOPHYSICAL INTERPRETATION MAP
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018



The SSSLs and ESVs are presented in the *Final Human Health and Ecological Screening Values and PAH Background Summary Report* (IT, 2000c). Background metals screening values are presented in the *Final Background Metals Survey Report, Fort McClellan, Alabama* (SAIC, 1998). Summary statistics for background metal samples collected at FTMC are included in Appendix J.

An integrated statistical and geochemical evaluation of metals in soil and groundwater was performed for Range J and is included in Appendix K. The evaluation was conducted following methodology outlined in the technical memorandum “Selecting Site-Related Chemicals for Human Health and Ecological Risk Assessments for FTMC, Revision 2” (Shaw, 2003).

The following sections and Tables 4-1 through 4-3 summarize the results of the comparison of detected constituents to the SSSLs, ESVs, and background screening values. A summary of validated analytical data is presented in Appendix H.

4.3.1 Surface Soil Analytical Results

Surface soil samples were collected from 32 locations for chemical analysis during the three phases of the supplemental RI at Range J, Parcel 202(7). Surface soil samples were collected from the uppermost foot of soil at the locations shown on Figures 2-2 and 2-3. Analytical results were compared to residential human health SSSLs, ESVs, and background screening values as presented in Table 4-1.

Metals. Eight surface soil samples collected during Phase III of the supplemental RI at Range J were analyzed for metals. A total of twenty metals were detected in the samples. The thallium results were flagged with a “B” data qualifier, signifying that this metal was also detected in an associated laboratory or field blank sample. A majority of the remaining metals results were flagged with a “J” data qualifier, indicating that the results were estimated concentrations. The concentrations of six metals (aluminum, arsenic, chromium, iron, thallium, and vanadium) exceeded SSSLs. Of these metals, only arsenic, chromium, iron, and vanadium exceeded their respective background concentrations:

- Arsenic (13.9 to 24.3 milligrams per kilogram [mg/kg]) exceeded its SSSL (0.4 mg/kg) and background (13.7 mg/kg) at three sample locations.
- Chromium (37.1 and 51.7 mg/kg) exceeded its SSSL (23.2 mg/kg) and background (37.0 mg/kg) at two sample locations. Both chromium results were “J” flagged, indicating that the concentrations were estimated.

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 1 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-GP01 JB0001 2-Dec-98 0- 2					RJR-202-GP02 JB0003 3-Dec-98 0- 2					RJR-202-GP03 JB0005 9-Dec-98 0- 1				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS																			
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	NR					NR					NR				
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	NR					NR					NR				
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	NR					NR					NR				
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	NR					NR					NR				
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	NR					NR					NR				
Calcium	mg/kg	1.72E+03	NA	NA	NR					NR					NR				
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	NR					NR					NR				
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	NR					NR					NR				
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	NR					NR					NR				
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	NR					NR					NR				
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	NR					NR					NR				
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	NR					NR					NR				
Manganese	mg/kg	1.58E+03	3.63E+02	1.00E+02	NR					NR					NR				
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	NR					NR					NR				
Nickel	mg/kg	1.03E+01	1.54E+02	3.00E+01	NR					NR					NR				
Potassium	mg/kg	8.00E+02	NA	NA	NR					NR					NR				
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	NR					NR					NR				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	NR					NR					NR				
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	NR					NR					NR				
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	NR					NR					NR				
VOLATILE ORGANIC COMPOUNDS																			
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	ND					ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	ND					ND					ND				
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	ND					ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	2.90E-02 J					ND					1.50E-02 J				
Bromomethane	mg/kg	NA	1.09E+01	NA	ND					ND					1.40E-03 B				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	ND					ND					ND				
Cumene	mg/kg	NA	7.77E-02	NA	ND					ND					ND				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	2.80E-03 B					3.30E-03 B					6.30E-03 B				
Naphthalene	mg/kg	NA	1.55E-02	1.00E-01	ND					ND					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	ND					ND					ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	ND					ND					ND				
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	ND					ND					ND				
SEMIVOLATILE ORGANIC COMPOUNDS																			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+02	ND					ND					ND				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	ND					ND					9.70E-02 B				

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 2 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-GP04 JB0009 7-Dec-98 0- 1					RJR-202-GP05 JB0011 8-Dec-98 0- 1					RJR-202-GP06 JB0013 4-Dec-98 0- 1				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS																			
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	NR					NR					NR				
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	NR					NR					NR				
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	NR					NR					NR				
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	NR					NR					NR				
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	NR					NR					NR				
Calcium	mg/kg	1.72E+03	NA	NA	NR					NR					NR				
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	NR					NR					NR				
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	NR					NR					NR				
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	NR					NR					NR				
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	NR					NR					NR				
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	NR					NR					NR				
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	NR					NR					NR				
Manganese	mg/kg	1.58E+03	3.63E+02	1.00E+02	NR					NR					NR				
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	NR					NR					NR				
Nickel	mg/kg	1.03E+01	1.54E+02	3.00E+01	NR					NR					NR				
Potassium	mg/kg	8.00E+02	NA	NA	NR					NR					NR				
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	NR					NR					NR				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	NR					NR					NR				
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	NR					NR					NR				
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	NR					NR					NR				
VOLATILE ORGANIC COMPOUNDS																			
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	ND					ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	8.30E-03 J					1.30E-02 J					ND				
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	ND					ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	2.20E-01 J					5.30E-01 B					3.90E-01 J				
Bromomethane	mg/kg	NA	1.09E+01	NA	2.90E-03 B					2.10E-03 B					2.80E-03 B				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	ND					ND					ND				
Cumene	mg/kg	NA	7.77E-02	NA	ND					ND					ND				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	4.70E-03 B					5.30E-03 B					5.80E-03 B				
Naphthalene	mg/kg	NA	1.55E+02	1.00E-01	ND					ND					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	ND					ND					ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	ND					ND					4.20E-03 B				
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	ND					ND					ND				
SEMIVOLATILE ORGANIC COMPOUNDS																			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+02	ND					ND					ND				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	7.90E-02 B					9.90E-02 B					6.60E-02 B				

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 3 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-GP07 JB0015 7-Dec-98 0- 1					RJR-202-GP08 JB0019 3-Dec-98 0- 1					RJR-202-GP09 JB0021 8-Dec-98 0- 1				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS																			
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	NR					NR					NR				
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	NR					NR					NR				
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	NR					NR					NR				
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	NR					NR					NR				
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	NR					NR					NR				
Calcium	mg/kg	1.72E+03	NA	NA	NR					NR					NR				
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	NR					NR					NR				
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	NR					NR					NR				
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	NR					NR					NR				
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	NR					NR					NR				
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	NR					NR					NR				
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	NR					NR					NR				
Manganese	mg/kg	1.58E+03	3.63E-02	1.00E+02	NR					NR					NR				
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	NR					NR					NR				
Nickel	mg/kg	1.03E+01	1.54E+02	3.00E+01	NR					NR					NR				
Potassium	mg/kg	8.00E+02	NA	NA	NR					NR					NR				
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	NR					NR					NR				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	NR					NR					NR				
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	NR					NR					NR				
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	NR					NR					NR				
VOLATILE ORGANIC COMPOUNDS																			
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	ND					ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	4.80E-03 J					ND					2.00E-02 J				
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	ND					ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	1.40E-01 J					ND					2.70E-01 J				
Bromomethane	mg/kg	NA	1.09E+01	NA	2.40E-03 B					ND					1.90E-03 B				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	ND					ND					ND				
Cumene	mg/kg	NA	7.77E-02	NA	ND					ND					ND				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	3.70E-03 B					3.50E-03 B					4.70E-03 B				
Naphthalene	mg/kg	NA	1.55E-02	1.00E-01	ND					ND					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	ND					ND					ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	ND					ND					ND				
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	ND					ND					1.30E-02				
SEMIVOLATILE ORGANIC COMPOUNDS																			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+02	ND					ND					ND				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	9.40E-02 B					7.10E-02 B					4.70E-02 B				

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 4 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-GP10 JB0023 4-Dec-98 0- 1					RJR-202-GP11 JB0025 7-Dec-98 0- 1					RJR-202-GP12 JB0029 3-Dec-98 0- 1				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS																			
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	NR					NR					NR				
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	NR					NR					NR				
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	NR					NR					NR				
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	NR					NR					NR				
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	NR					NR					NR				
Calcium	mg/kg	1.72E+03	NA	NA	NR					NR					NR				
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	NR					NR					NR				
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	NR					NR					NR				
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	NR					NR					NR				
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	NR					NR					NR				
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	NR					NR					NR				
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	NR					NR					NR				
Manganese	mg/kg	1.58E+03	3.63E-02	1.00E+02	NR					NR					NR				
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	NR					NR					NR				
Nickel	mg/kg	1.03E+01	1.54E-02	3.00E+01	NR					NR					NR				
Potassium	mg/kg	8.00E+02	NA	NA	NR					NR					NR				
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	NR					NR					NR				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	NR					NR					NR				
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	NR					NR					NR				
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	NR					NR					NR				
VOLATILE ORGANIC COMPOUNDS																			
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	ND					ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	ND					ND					ND				
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	ND					ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	ND					1.10E-01 J					2.50E-02 J				
Bromomethane	mg/kg	NA	1.09E+01	NA	3.80E-03 B					2.20E-03 B					ND				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	ND					ND					ND				
Cumene	mg/kg	NA	7.77E-02	NA	ND					ND					ND				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	6.20E-03 B					4.20E-03 B					2.50E-03 B				
Naphthalene	mg/kg	NA	1.55E-02	1.00E-01	ND					ND					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	ND					ND					ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	ND					ND					ND				
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	ND					ND					ND				
SEMIVOLATILE ORGANIC COMPOUNDS																			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+02	ND					ND					ND				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	7.00E-02 B					6.50E-02 B					5.80E-02 B				

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 5 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-GP13 JB0031 8-Dec-98 0- 1					RJR-202-GP14 JB0033 9-Dec-98 0- 1					RJR-202-GP15 JB0035 9-Dec-98 0- 1				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS																			
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	NR					NR					NR				
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	NR					NR					NR				
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	NR					NR					NR				
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	NR					NR					NR				
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	NR					NR					NR				
Calcium	mg/kg	1.72E+03	NA	NA	NR					NR					NR				
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	NR					NR					NR				
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	NR					NR					NR				
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	NR					NR					NR				
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	NR					NR					NR				
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	NR					NR					NR				
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	NR					NR					NR				
Manganese	mg/kg	1.58E+03	3.63E-02	1.00E+02	NR					NR					NR				
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	NR					NR					NR				
Nickel	mg/kg	1.03E+01	1.54E+02	3.00E+01	NR					NR					NR				
Potassium	mg/kg	8.00E+02	NA	NA	NR					NR					NR				
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	NR					NR					NR				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	NR					NR					NR				
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	NR					NR					NR				
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	NR					NR					NR				
VOLATILE ORGANIC COMPOUNDS																			
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	ND					ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	ND					ND					ND				
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	ND					ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	5.30E-02 J					6.60E-02 J					1.20E-01 J				
Bromomethane	mg/kg	NA	1.09E+01	NA	1.80E-03 B					1.80E-03 B					ND				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	ND					ND					ND				
Cumene	mg/kg	NA	7.77E-02	NA	ND					ND					ND				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	5.10E-03 B					5.60E-03 B					4.70E-03 B				
Naphthalene	mg/kg	NA	1.55E-02	1.00E-01	ND					ND					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	ND					ND					ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	ND					ND					ND				
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	ND					ND					ND				
SEMIVOLATILE ORGANIC COMPOUNDS																			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+02	ND					ND					ND				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	7.20E-02 B					5.90E-02 B					6.30E-02 B				

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 6 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-GP16 JB0037 9-Dec-98 0- 1					RJR-202-GP17 JBB0001 20-Jun-01 0- 1					RJR-202-GP18 JBB0003 20-Jun-01 0- 1				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS																			
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	NR					1.18E+04			YES	YES	3.85E+03				YES
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	NR					1.10E+00 J					5.90E-01 J				
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	NR					1.32E+01			YES	YES	7.00E+00			YES	
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	NR					2.32E+01 J					1.99E+01 J				
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	NR					2.40E-01 J					2.40E-01 J				
Calcium	mg/kg	1.72E+03	NA	NA	NR					6.93E+02 J					3.24E+02 J				
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	NR					5.17E+01 J	YES	YES	YES	YES	2.16E+01 J				YES
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	NR					2.00E+00 J					2.70E+00 J				
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	NR					8.40E+00 J					5.80E+00 J				
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	NR					2.68E+04		YES	YES	YES	1.01E+04		YES	YES	
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	NR					9.60E+00 J					6.70E+00 J				
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	NR					2.04E+02 J					1.28E+02 J				
Manganese	mg/kg	1.58E+03	3.63E+02	1.00E+02	NR					8.43E+01 J					2.16E+02 J				YES
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	NR					1.10E-01	YES		YES	YES	1.90E-02 J				
Nickel	mg/kg	1.03E+01	1.54E+02	3.00E+01	NR					5.10E+00 J					3.20E+00 J				
Potassium	mg/kg	8.00E+02	NA	NA	NR					1.34E+02 J					5.70E+01 J				
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	NR					7.40E-01	YES				ND				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	NR					6.80E-01 B			YES		6.40E-01 B		YES		
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	NR					5.34E+01			YES	YES	2.08E+01				YES
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	NR					1.76E+01 J					1.81E+01 J				
VOLATILE ORGANIC COMPOUNDS																			
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	ND					ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	7.50E-03 J					ND					ND				
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	ND					ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	3.30E-01 J					3.30E-02 B					7.80E-02 B				
Bromomethane	mg/kg	NA	1.09E+01	NA	2.80E-03 B					ND					ND				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	ND					ND					ND				
Cumene	mg/kg	NA	7.77E+02	NA	ND					ND					ND				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	6.20E-03 B					2.90E-03 B					2.80E-03 B				
Naphthalene	mg/kg	NA	1.55E+02	1.00E-01	ND					ND					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	ND					ND					ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	5.10E-03 B					9.80E-04 B					1.80E-03 J				
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	4.30E-03 J					ND					ND				
SEMIVOLATILE ORGANIC COMPOUNDS																			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+02	ND					NR					NR				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	5.10E-02 B					NR					NR				

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 7 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-GP19 JBB0005 20-Jun-01 0-1					RJR-202-GP20 JBB0007 20-Jun-01 0-1					RJR-202-GP21 JBB0009 20-Jun-01 0-1				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS																			
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	7.45E+03				YES	6.71E+03				YES	9.05E+03			YES	YES
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	6.70E-01	J				8.70E-01	J				1.30E+00	J			
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	1.50E+01		YES	YES	YES	1.39E+01		YES	YES	YES	2.43E+01		YES	YES	YES
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	1.51E+01	J				1.56E+01	J				1.62E+01	J			
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	3.80E-01	J				4.50E-01	J				5.30E-01	J			
Calcium	mg/kg	1.72E+03	NA	NA	3.47E+02	J				3.82E+02	J				6.06E+02	J			
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	2.50E+01	J		YES	YES	1.72E+01	J			YES	3.71E+01	J	YES	YES	YES
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	3.10E+00	J				5.00E+00	J				6.60E+00	J			
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	1.38E+01	J	YES			1.69E+01	J	YES			2.46E+01	J	YES		
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	2.37E+04			YES	YES	2.09E+04			YES	YES	3.82E+04		YES	YES	YES
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	8.60E+00	J				7.90E+00	J				9.60E+00	J			
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	1.69E+02	J				1.88E+02	J				1.97E+02	J			
Manganese	mg/kg	1.58E+03	3.63E+02	1.00E+02	5.32E+01	J				7.09E+01	J				1.17E+02	J			YES
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	7.80E-02					4.20E-02					4.00E-02				
Nickel	mg/kg	1.03E+01	1.54E+02	3.00E+01	5.20E+00	J				9.70E+00	J				1.11E+01	J	YES		
Potassium	mg/kg	8.00E+02	NA	NA	1.40E+02	J				1.52E+02	J				2.24E+02	J			
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	ND					ND					ND				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	6.90E-01	B		YES		6.00E-01	B		YES		6.30E-01	B		YES	
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	5.18E+01				YES	4.25E+01				YES	7.43E+01		YES	YES	YES
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	3.18E+01	J				6.04E+01	J	YES		YES	6.95E+01	J	YES	YES	YES
VOLATILE ORGANIC COMPOUNDS																			
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	2.40E-03	J				ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	7.90E-04	J				ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	3.30E-02	B				ND					5.80E-03	B			
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	8.20E-03	J				ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	3.90E-01					1.10E-02	B				1.30E-01	B			
Bromomethane	mg/kg	NA	1.09E+01	NA	ND					ND					ND				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	ND					ND					ND				
Cumene	mg/kg	NA	7.77E+02	NA	ND					ND					ND				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	2.50E-03	B				2.30E-03	B				2.50E-03	B			
Naphthalene	mg/kg	NA	1.55E+02	1.00E-01	8.80E-03					ND					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	1.80E-03	J				1.30E-03	J				ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	1.70E-03	B				1.60E-03	B				1.20E-03	B			
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	1.60E-03	J				ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	4.80E-02					ND					ND				
SEMIVOLATILE ORGANIC COMPOUNDS																			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+02	NR					NR					NR				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	NR					NR					NR				

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 8 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-GP22 JBB0011 20-Jun-01 0- 1					RJR-202-GP23 JBB0013 20-Jun-01 0- 1					RJR-202-GP24 JBB0015 20-Jun-01 0- 1				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS																			
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	7.71E+03				YES	9.38E+03			YES	YES	1.16E+04			YES	YES
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	6.60E-01	J				7.40E-01	J				9.40E-01	J			
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	7.50E+00		YES			8.50E+00		YES			9.20E+00		YES		
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	3.36E+01					3.74E+01					2.61E+01				
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	3.00E-01	J				3.60E-01	J				2.70E-01	J			
Calcium	mg/kg	1.72E+03	NA	NA	4.74E+02	J				2.28E+03	J	YES			3.85E+03	J	YES		
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	1.88E+01	J		YES		1.92E+01	J			YES	1.89E+01	J			YES
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	4.40E+00	J				3.40E+00	J				2.20E+00	J			
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	6.90E+00	J				7.60E+00	J				7.60E+00	J			
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	1.47E+04		YES	YES		1.63E+04		YES	YES		2.00E+04		YES	YES	
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	9.80E+00	J				1.03E+01	J				8.20E+00	J			
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	2.03E+02	J				2.65E+02	J				2.14E+03	J	YES		
Manganese	mg/kg	1.58E+03	3.63E+02	1.00E+02	1.75E+02	J		YES		1.81E+02	J		YES		8.22E+01	J			
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	3.40E-02	J				4.10E-02					7.00E-02				
Nickel	mg/kg	1.03E+01	1.54E+02	3.00E+01	4.70E+00	J				4.90E+00	J				4.60E+00	J			
Potassium	mg/kg	8.00E+02	NA	NA	1.13E+02	J				1.51E+02	J				1.47E+02	J			
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	4.60E-01	J				4.30E-01	J				ND				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	6.30E-01	B	YES			5.40E-01	B	YES			ND				
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	2.82E+01	J		YES		3.32E+01	J		YES	YES	4.02E+01	J			YES
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	2.08E+01	J				6.05E+01	J	YES		YES	1.71E+01	J			
VOLATILE ORGANIC COMPOUNDS																			
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	ND					ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	ND					ND					ND				
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	ND					ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	3.10E-02	B				2.50E-02	B				8.40E-03	B			
Bromomethane	mg/kg	NA	1.09E+01	NA	ND					ND					ND				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	ND					ND					ND				
Cumene	mg/kg	NA	7.77E+02	NA	ND					ND					ND				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	2.00E-03	B				2.00E-03	B				2.30E-03	B			
Naphthalene	mg/kg	NA	1.55E+02	1.00E-01	ND					ND					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	ND					ND					ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	1.50E-03	B				1.40E-03	B				1.30E-03	J			
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	ND					ND					ND				
SEMIVOLATILE ORGANIC COMPOUNDS																			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+02	NR					NR					NR				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	NR					NR					NR				

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 9 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-MW04 JB0050 5-Jan-99 0- 1					RJR-202-MW05 JB0052 11-Jan-99 0- 1					RJR-202-MW06 JB0054 14-Jan-99 0- 1				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS																			
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	NR					NR					NR				
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	NR					NR					NR				
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	NR					NR					NR				
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	NR					NR					NR				
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	NR					NR					NR				
Calcium	mg/kg	1.72E+03	NA	NA	NR					NR					NR				
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	NR					NR					NR				
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	NR					NR					NR				
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	NR					NR					NR				
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	NR					NR					NR				
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	NR					NR					NR				
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	NR					NR					NR				
Manganese	mg/kg	1.58E+03	3.63E+02	1.00E+02	NR					NR					NR				
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	NR					NR					NR				
Nickel	mg/kg	1.03E+01	1.54E+02	3.00E+01	NR					NR					NR				
Potassium	mg/kg	8.00E+02	NA	NA	NR					NR					NR				
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	NR					NR					NR				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	NR					NR					NR				
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	NR					NR					NR				
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	NR					NR					NR				
VOLATILE ORGANIC COMPOUNDS																			
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	ND					ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	ND					ND					3.60E-03 J				
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	ND					ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	7.80E-03 B					2.80E-02 J					1.10E-01 J				
Bromomethane	mg/kg	NA	1.09E+01	NA	4.80E-03 B					2.20E-03 B					2.20E-03 B				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	4.30E-03 B					ND					ND				
Cumene	mg/kg	NA	7.77E+02	NA	ND					ND					5.70E-03 J				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	4.60E-03 B					2.80E-03 B					3.60E-03 B				
Naphthalene	mg/kg	NA	1.55E+02	1.00E-01	ND					ND					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	ND					ND					ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	3.30E-03 J					ND					ND				
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	ND					ND					4.40E-03 J				
SEMI-VOLATILE ORGANIC COMPOUNDS																			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+01	ND					ND					8.30E-02 B				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	6.40E-02 J					6.10E-02 J					7.00E-02 B				

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 10 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-MW07 JB0056 26-Jan-99 0- 1					RJR-202-MW08 JB0059 18-Jan-99 0- 1					RJR-202-MW09 JB0061 19-Jan-99 0- 1				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS																			
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	NR					NR					NR				
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	NR					NR					NR				
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	NR					NR					NR				
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	NR					NR					NR				
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	NR					NR					NR				
Calcium	mg/kg	1.72E+03	NA	NA	NR					NR					NR				
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	NR					NR					NR				
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	NR					NR					NR				
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	NR					NR					NR				
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	NR					NR					NR				
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	NR					NR					NR				
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	NR					NR					NR				
Manganese	mg/kg	1.58E+03	3.63E+02	1.00E+02	NR					NR					NR				
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	NR					NR					NR				
Nickel	mg/kg	1.03E+01	1.54E+02	3.00E+01	NR					NR					NR				
Potassium	mg/kg	8.00E+02	NA	NA	NR					NR					NR				
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	NR					NR					NR				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	NR					NR					NR				
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	NR					NR					NR				
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	NR					NR					NR				
VOLATILE ORGANIC COMPOUNDS																			
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	ND					ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	ND					1.70E-02 J					ND				
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	ND					ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	1.50E-02 J					5.20E-01 J					2.10E+01 J				YES
Bromomethane	mg/kg	NA	1.09E+01	NA	ND					9.90E-03 B					2.30E-02 J				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	ND					ND					ND				
Cumene	mg/kg	NA	7.77E+02	NA	ND					ND					ND				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	3.70E-03 B					1.30E-02 B					3.80E-02 J				
Naphthalene	mg/kg	NA	1.55E+02	1.00E-01	ND					ND					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	ND					ND					ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	ND					ND					ND				
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	ND					ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	ND					ND					ND				
SEMIVOLATILE ORGANIC COMPOUNDS																			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+02	ND					ND					ND				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	5.80E-02 B					ND					ND				

Table 4-1

Surface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 11 of 12)

Sample Location Sample Number Sample Date Sample Depth (Feet)					RJR-202-MW10 JB0063 21-Jan-99 0- 1					RJR-202-MW12 JB0065 27-Jan-99 0- 2				
	Units	BKG ^a	SSSL ^b	ESV ^b	Result	Qual	>BKG	>SSSL	>ESV	Result	Qual	>BKG	>SSSL	>ESV
METALS														
Aluminum	mg/kg	1.63E+04	7.80E+03	5.00E+01	NR					NR				
Antimony	mg/kg	1.99E+00	3.11E+00	3.50E+00	NR					NR				
Arsenic	mg/kg	1.37E+01	4.26E-01	1.00E+01	NR					NR				
Barium	mg/kg	1.24E+02	5.47E+02	1.65E+02	NR					NR				
Beryllium	mg/kg	8.00E-01	9.60E+00	1.10E+00	NR					NR				
Calcium	mg/kg	1.72E+03	NA	NA	NR					NR				
Chromium	mg/kg	3.70E+01	2.32E+01	4.00E-01	NR					NR				
Cobalt	mg/kg	1.52E+01	4.68E+02	2.00E+01	NR					NR				
Copper	mg/kg	1.27E+01	3.13E+02	4.00E+01	NR					NR				
Iron	mg/kg	3.42E+04	2.34E+03	2.00E+02	NR					NR				
Lead	mg/kg	4.01E+01	4.00E+02	5.00E+01	NR					NR				
Magnesium	mg/kg	1.03E+03	NA	4.40E+05	NR					NR				
Manganese	mg/kg	1.58E+03	3.63E+02	1.00E+02	NR					NR				
Mercury	mg/kg	8.00E-02	2.33E+00	1.00E-01	NR					NR				
Nickel	mg/kg	1.03E+01	1.54E+02	3.00E+01	NR					NR				
Potassium	mg/kg	8.00E+02	NA	NA	NR					NR				
Selenium	mg/kg	4.80E-01	3.91E+01	8.10E-01	NR					NR				
Thallium	mg/kg	3.43E+00	5.08E-01	1.00E+00	NR					NR				
Vanadium	mg/kg	5.88E+01	5.31E+01	2.00E+00	NR					NR				
Zinc	mg/kg	4.06E+01	2.34E+03	5.00E+01	NR					NR				
VOLATILE ORGANIC COMPOUNDS														
1,2,4-Trimethylbenzene	mg/kg	NA	3.88E+02	1.00E-01	ND					ND				
1,2-Dimethylbenzene	mg/kg	NA	1.55E+04	5.00E-02	ND					ND				
2-Butanone	mg/kg	NA	4.66E+03	8.96E+01	ND					ND				
2-Hexanone	mg/kg	NA	3.11E+02	1.26E+01	ND					ND				
Acetone	mg/kg	NA	7.76E+02	2.50E+00	2.90E-01 J					6.90E-03 J				
Bromomethane	mg/kg	NA	1.09E+01	NA	ND					ND				
Chloromethane	mg/kg	NA	4.85E+01	1.00E-01	ND					ND				
Cumene	mg/kg	NA	7.77E+02	NA	ND					ND				
Methylene chloride	mg/kg	NA	8.41E+01	2.00E+00	1.30E-02 B					3.10E-03 B				
Naphthalene	mg/kg	NA	1.55E+02	1.00E-01	1.70E-02 J					ND				
Toluene	mg/kg	NA	1.55E+03	5.00E-02	ND					ND				
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.00E-01	ND					ND				
m,p-Xylenes	mg/kg	NA	1.55E+04	5.00E-02	ND					ND				
p-Cymene	mg/kg	NA	1.55E+03	NA	6.30E-02					ND				
SEMIVOLATILE ORGANIC COMPOUNDS														
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	2.00E+02	ND					ND				
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.30E-01	ND					ND				

Table 4-1

Surface Soil Analytical Results Range J - Pelham Range, Parcel 202(7) Fort McClellan, Calhoun County, Alabama

(Page 12 of 12)

Analyses performed using U.S. Environmental Protection Agency (EPA) SW-846 analytical methods.

^a BKG - Background. Concentration listed is two times (2x) the arithmetic mean of background metals concentration given in SAIC, 1998, *Final Background Metals Survey Report, Fort McClellan, Alabama*, July.

^b Residential human health site-specific screening level (SSSL) and ecological screening value (ESV) as given in IT, 2000, *Final Human Health and Ecological Screening Values and PAH Background Summary Report, Fort McClellan, Calhoun County, Alabama*, July.

B - Analyte detected in laboratory or field blank at concentration greater than the reporting limit (and greater than zero).

J - Compound was positively identified; reported value is an estimated concentration.

mg/kg - Milligrams per kilogram.

NA - Not available.

ND - Not detected.

NR - Not requested.

Qual - Data validation qualifier.

Table 4-2

**Subsurface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 1 of 10)

Sample Location Sample Number Sample Date Sample Depth (Feet)				RJR-202-GP01 JB0002 2-Dec-98 10 - 12				RJR-202-GP02 JB0004 3-Dec-98 10 - 12				RJR-202-GP03 JB0008 9-Dec-98 10 - 12				RJR-202-GP04 JB0010 7-Dec-98 10 - 12			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS																			
Aluminum	mg/kg	1.36E+04	7.80E+03	NR				NR				NR				NR			
Antimony	mg/kg	1.31E+00	3.11E+00	NR				NR				NR				NR			
Arsenic	mg/kg	1.83E+01	4.26E-01	NR				NR				NR				NR			
Barium	mg/kg	2.34E+02	5.47E+02	NR				NR				NR				NR			
Beryllium	mg/kg	8.60E-01	9.60E+00	NR				NR				NR				NR			
Calcium	mg/kg	6.37E+02	NA	NR				NR				NR				NR			
Chromium	mg/kg	3.83E+01	2.32E+01	NR				NR				NR				NR			
Cobalt	mg/kg	1.75E+01	4.68E+02	NR				NR				NR				NR			
Copper	mg/kg	1.94E+01	3.13E+02	NR				NR				NR				NR			
Iron	mg/kg	4.48E+04	2.34E+03	NR				NR				NR				NR			
Lead	mg/kg	3.85E+01	4.00E+02	NR				NR				NR				NR			
Magnesium	mg/kg	7.66E+02	NA	NR				NR				NR				NR			
Manganese	mg/kg	1.36E+03	3.63E+02	NR				NR				NR				NR			
Mercury	mg/kg	7.00E-02	2.33E+00	NR				NR				NR				NR			
Nickel	mg/kg	1.29E+01	1.54E+02	NR				NR				NR				NR			
Potassium	mg/kg	7.11E+02	NA	NR				NR				NR				NR			
Selenium	mg/kg	4.70E-01	3.91E+01	NR				NR				NR				NR			
Thallium	mg/kg	1.40E+00	5.08E-01	NR				NR				NR				NR			
Vanadium	mg/kg	6.49E+01	5.31E+01	NR				NR				NR				NR			
Zinc	mg/kg	3.49E+01	2.34E+03	NR				NR				NR				NR			
VOLATILE ORGANIC COMPOUNDS																			
2-Butanone	mg/kg	NA	4.66E+03	ND				ND				ND				ND			
Acetone	mg/kg	NA	7.76E+02	ND				1.20E-02 J				1.10E-02 J				ND			
Bromomethane	mg/kg	NA	1.09E+01	ND				ND				ND				2.70E-03 B			
Carbon tetrachloride	mg/kg	NA	4.83E+00	ND				ND				ND				ND			
Chloroform	mg/kg	NA	1.03E+02	ND				ND				ND				ND			
Cumene	mg/kg	NA	7.77E+02	ND				ND				ND				ND			
Methylene chloride	mg/kg	NA	8.41E+01	3.00E-03 B				3.60E-03 B				1.10E-02 B				7.50E-03 B			
Naphthalene	mg/kg	NA	1.55E+02	ND				ND				ND				ND			
Toluene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
Trichlorofluoromethane	mg/kg	NA	2.33E+03	ND				ND				ND				ND			
p-Cymene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
Benzo(a)anthracene	mg/kg	NA	8.51E-01	ND				ND				ND				ND			
Chrysene	mg/kg	NA	8.61E+01	ND				ND				ND				ND			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	ND				ND				ND				ND			
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	6.60E-02 B				5.80E-02 B				6.30E-02 B				8.60E-02 B			

Table 4-2

Subsurface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 2 of 10)

Sample Location Sample Number Sample Date Sample Depth (Feet)				RJR-202-GP05 JB0012 8-Dec-98 1 - 2				RJR-202-GP06 JB0014 4-Dec-98 10 - 12				RJR-202-GP07 JB0016 7-Dec-98 10 - 12				RJR-202-GP08 JB0020 3-Dec-98 1 - 2			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS																			
Aluminum	mg/kg	1.36E+04	7.80E+03	NR				NR				NR				NR			
Antimony	mg/kg	1.31E+00	3.11E+00	NR				NR				NR				NR			
Arsenic	mg/kg	1.83E+01	4.26E-01	NR				NR				NR				NR			
Barium	mg/kg	2.34E+02	5.47E+02	NR				NR				NR				NR			
Beryllium	mg/kg	8.60E-01	9.60E+00	NR				NR				NR				NR			
Calcium	mg/kg	6.37E+02	NA	NR				NR				NR				NR			
Chromium	mg/kg	3.83E+01	2.32E+01	NR				NR				NR				NR			
Cobalt	mg/kg	1.75E+01	4.68E+02	NR				NR				NR				NR			
Copper	mg/kg	1.94E+01	3.13E+02	NR				NR				NR				NR			
Iron	mg/kg	4.48E+04	2.34E+03	NR				NR				NR				NR			
Lead	mg/kg	3.85E+01	4.00E+02	NR				NR				NR				NR			
Magnesium	mg/kg	7.66E+02	NA	NR				NR				NR				NR			
Manganese	mg/kg	1.36E+03	3.63E+02	NR				NR				NR				NR			
Mercury	mg/kg	7.00E-02	2.33E+00	NR				NR				NR				NR			
Nickel	mg/kg	1.29E+01	1.54E+02	NR				NR				NR				NR			
Potassium	mg/kg	7.11E+02	NA	NR				NR				NR				NR			
Selenium	mg/kg	4.70E-01	3.91E+01	NR				NR				NR				NR			
Thallium	mg/kg	1.40E+00	5.08E-01	NR				NR				NR				NR			
Vanadium	mg/kg	6.49E+01	5.31E+01	NR				NR				NR				NR			
Zinc	mg/kg	3.49E+01	2.34E+03	NR				NR				NR				NR			
VOLATILE ORGANIC COMPOUNDS																			
2-Butanone	mg/kg	NA	4.66E+03	ND				ND				ND				ND			
Acetone	mg/kg	NA	7.76E+02	2.20E+00	B			1.10E-02	J			ND				8.00E-01	B		
Bromomethane	mg/kg	NA	1.09E+01	ND				2.10E-03	B			2.00E-03	B			ND			
Carbon tetrachloride	mg/kg	NA	4.83E+00	ND				ND				ND				ND			
Chloroform	mg/kg	NA	1.03E+02	ND				ND				ND				ND			
Cumene	mg/kg	NA	7.77E+02	ND				ND				ND				ND			
Methylene chloride	mg/kg	NA	8.41E+01	6.00E-03	B			5.80E-03	B			6.80E-03	B			3.50E-03	B		
Naphthalene	mg/kg	NA	1.55E+02	ND				ND				ND				ND			
Toluene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
Trichlorofluoromethane	mg/kg	NA	2.33E+03	ND				ND				ND				ND			
p-Cymene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
Benzo(a)anthracene	mg/kg	NA	8.51E-01	ND				ND				ND				ND			
Chrysene	mg/kg	NA	8.61E+01	ND				ND				ND				ND			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	ND				ND				ND				ND			
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	7.60E-02	B			ND				8.40E-02	B			5.90E-02	B		

Table 4-2

**Subsurface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 3 of 10)

Sample Location Sample Number Sample Date Sample Depth (Feet)				RJR-202-GP09 JB0022 8-Dec-98 2 - 4				RJR-202-GP10 JB0024 4-Dec-98 10 - 12				RJR-202-GP11 JB0028 7-Dec-98 8 - 10				RJR-202-GP12 JB0030 3-Dec-98 10 - 12			
Parameter	Units	BKG ^a	SSSL ^a	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS																			
Aluminum	mg/kg	1.36E+04	7.80E+03	NR				NR				NR				NR			
Antimony	mg/kg	1.31E+00	3.11E+00	NR				NR				NR				NR			
Arsenic	mg/kg	1.83E+01	4.26E-01	NR				NR				NR				NR			
Barium	mg/kg	2.34E+02	5.47E+02	NR				NR				NR				NR			
Beryllium	mg/kg	8.60E-01	9.60E+00	NR				NR				NR				NR			
Calcium	mg/kg	6.37E+02	NA	NR				NR				NR				NR			
Chromium	mg/kg	3.83E+01	2.32E+01	NR				NR				NR				NR			
Cobalt	mg/kg	1.75E+01	4.68E+02	NR				NR				NR				NR			
Copper	mg/kg	1.94E+01	3.13E+02	NR				NR				NR				NR			
Iron	mg/kg	4.48E+04	2.34E+03	NR				NR				NR				NR			
Lead	mg/kg	3.85E+01	4.00E+02	NR				NR				NR				NR			
Magnesium	mg/kg	7.66E+02	NA	NR				NR				NR				NR			
Manganese	mg/kg	1.36E+03	3.63E+02	NR				NR				NR				NR			
Mercury	mg/kg	7.00E-02	2.33E+00	NR				NR				NR				NR			
Nickel	mg/kg	1.29E+01	1.54E+02	NR				NR				NR				NR			
Potassium	mg/kg	7.11E+02	NA	NR				NR				NR				NR			
Selenium	mg/kg	4.70E-01	3.91E+01	NR				NR				NR				NR			
Thallium	mg/kg	1.40E+00	5.08E-01	NR				NR				NR				NR			
Vanadium	mg/kg	6.49E+01	5.31E+01	NR				NR				NR				NR			
Zinc	mg/kg	3.49E+01	2.34E+03	NR				NR				NR				NR			
VOLATILE ORGANIC COMPOUNDS																			
2-Butanone	mg/kg	NA	4.66E+03	1.10E-02	J			ND				ND				ND			
Acetone	mg/kg	NA	7.76E+02	1.80E-01	J			ND				3.70E-02	J			1.00E-02	J		
Bromomethane	mg/kg	NA	1.09E+01	2.00E-03	B			2.80E-03	B			2.00E-03	B			ND			
Carbon tetrachloride	mg/kg	NA	4.83E+00	ND				ND				2.60E-02				ND			
Chloroform	mg/kg	NA	1.03E+02	ND				ND				4.10E-03	J			ND			
Cumene	mg/kg	NA	7.77E+02	ND				ND				ND				ND			
Methylene chloride	mg/kg	NA	8.41E+01	4.60E-03	B			6.40E-03	B			4.00E-03	B			3.80E-03	B		
Naphthalene	mg/kg	NA	1.55E+02	ND				ND				ND				ND			
Toluene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
Trichlorofluoromethane	mg/kg	NA	2.33E+03	ND				ND				ND				ND			
p-Cymene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
Benzo(a)anthracene	mg/kg	NA	8.51E-01	ND				ND				ND				ND			
Chrysene	mg/kg	NA	8.61E+01	ND				ND				ND				ND			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	ND				ND				ND				ND			
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	7.30E-02	B			6.70E-02	B			9.40E-02	B			6.10E-02	B		

Table 4-2

**Subsurface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 4 of 10)

Sample Location Sample Number Sample Date Sample Depth (Feet)				RJR-202-GP13 JB0032 8-Dec-98 10 - 12				RJR-202-GP14 JB0034 9-Dec-98 10 - 12				RJR-202-GP15 JB0036 9-Dec-98 10 - 12				RJR-202-GP16 JB0038 9-Dec-98 10 - 12			
Parameter	Units	BKG ^a	SSSL ^a	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS																			
Aluminum	mg/kg	1.36E+04	7.80E+03	NR				NR				NR				NR			
Antimony	mg/kg	1.31E+00	3.11E+00	NR				NR				NR				NR			
Arsenic	mg/kg	1.83E+01	4.26E-01	NR				NR				NR				NR			
Barium	mg/kg	2.34E+02	5.47E+02	NR				NR				NR				NR			
Beryllium	mg/kg	8.60E-01	9.60E+00	NR				NR				NR				NR			
Calcium	mg/kg	6.37E+02	NA	NR				NR				NR				NR			
Chromium	mg/kg	3.83E+01	2.32E+01	NR				NR				NR				NR			
Cobalt	mg/kg	1.75E+01	4.68E+02	NR				NR				NR				NR			
Copper	mg/kg	1.94E+01	3.13E+02	NR				NR				NR				NR			
Iron	mg/kg	4.48E+04	2.34E+03	NR				NR				NR				NR			
Lead	mg/kg	3.85E+01	4.00E+02	NR				NR				NR				NR			
Magnesium	mg/kg	7.66E+02	NA	NR				NR				NR				NR			
Manganese	mg/kg	1.36E+03	3.63E+02	NR				NR				NR				NR			
Mercury	mg/kg	7.00E-02	2.33E+00	NR				NR				NR				NR			
Nickel	mg/kg	1.29E+01	1.54E+02	NR				NR				NR				NR			
Potassium	mg/kg	7.11E+02	NA	NR				NR				NR				NR			
Selenium	mg/kg	4.70E-01	3.91E+01	NR				NR				NR				NR			
Thallium	mg/kg	1.40E+00	5.08E-01	NR				NR				NR				NR			
Vanadium	mg/kg	6.49E+01	5.31E+01	NR				NR				NR				NR			
Zinc	mg/kg	3.49E+01	2.34E+03	NR				NR				NR				NR			
VOLATILE ORGANIC COMPOUNDS																			
2-Butanone	mg/kg	NA	4.66E+03	ND				ND				ND				ND			
Acetone	mg/kg	NA	7.76E+02	1.70E-02	J			6.70E-03	J			3.20E-02	J			1.20E-01	J		
Bromomethane	mg/kg	NA	1.09E+01	1.50E-03	B			ND				ND				ND			
Carbon tetrachloride	mg/kg	NA	4.83E+00	ND				ND				ND				2.60E-02			
Chloroform	mg/kg	NA	1.03E+02	ND				ND				ND				1.00E-02			
Cumene	mg/kg	NA	7.77E+02	ND				ND				ND				ND			
Methylene chloride	mg/kg	NA	8.41E+01	4.10E-03	B			4.60E-03	B			5.80E-03	B			8.10E-03	B		
Naphthalene	mg/kg	NA	1.55E+02	ND				ND				ND				ND			
Toluene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
Trichlorofluoromethane	mg/kg	NA	2.33E+03	ND				ND				ND				3.20E-03	B		
p-Cymene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
Benzo(a)anthracene	mg/kg	NA	8.51E-01	ND				ND				ND				ND			
Chrysene	mg/kg	NA	8.61E+01	ND				ND				ND				ND			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	ND				ND				ND				ND			
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	9.40E-02	B			5.30E-02	B			7.50E-02	B			6.40E-02	B		

Table 4-2

**Subsurface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 5 of 10)

Sample Location Sample Number Sample Date Sample Depth (Feet)				RJR-202-GP17 JBB0002 20-Jun-01 11 - 12				RJR-202-GP18 JBB0004 20-Jun-01 11 - 12				RJR-202-GP19 JBB0006 20-Jun-01 11 - 12				RJR-202-GP20 JBB0008 20-Jun-01 11 - 12			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS																			
Aluminum	mg/kg	1.36E+04	7.80E+03	5.64E+03				7.46E+03				7.57E+03				7.61E+03			
Antimony	mg/kg	1.31E+00	3.11E+00	1.20E+00	J			1.50E+00	J	YES		8.00E-01	J			1.40E+00	J	YES	
Arsenic	mg/kg	1.83E+01	4.26E-01	2.86E+01		YES	YES	6.32E+01		YES	YES	2.17E+01		YES	YES	3.84E+01		YES	YES
Barium	mg/kg	2.34E+02	5.47E+02	3.40E+00	J			5.00E+00	J			4.00E+00	J			5.30E+00	J		
Beryllium	mg/kg	8.60E-01	9.60E+00	6.60E-01	J			1.80E+00	J	YES		7.30E-01	J			3.00E+00	J	YES	
Calcium	mg/kg	6.37E+02	NA	2.43E+01	J			1.45E+01	J			ND				1.49E+01	J		
Chromium	mg/kg	3.83E+01	2.32E+01	1.64E+01	J			2.33E+01	J		YES	2.11E+01	J			2.43E+01	J		YES
Cobalt	mg/kg	1.75E+01	4.68E+02	8.00E+00	J			6.75E+01	J	YES		8.20E+00	J			2.99E+01	J	YES	
Copper	mg/kg	1.94E+01	3.13E+02	2.88E+01	J	YES		6.55E+01	J	YES		3.42E+01	J	YES		5.70E+01	J	YES	
Iron	mg/kg	4.48E+04	2.34E+03	3.04E+04			YES	4.74E+04		YES	YES	3.15E+04			YES	6.49E+04		YES	YES
Lead	mg/kg	3.85E+01	4.00E-02	1.11E+01	J			3.41E+01	J			1.27E+01	J			2.56E+01	J		
Magnesium	mg/kg	7.66E+02	NA	8.20E+01	J			1.44E+02	J			1.05E+02	J			1.74E+02	J		
Manganese	mg/kg	1.36E+03	3.63E+02	1.28E+02	J			7.10E+02	J		YES	8.09E+01	J			1.51E+02	J		
Mercury	mg/kg	7.00E-02	2.33E+00	7.20E-02		YES		4.00E-02	J			4.30E-02				5.60E-02			
Nickel	mg/kg	1.29E+01	1.54E+02	1.47E+01	J	YES		5.73E+01	J	YES		1.54E+01	J	YES		3.66E+01	J	YES	
Potassium	mg/kg	7.11E+02	NA	1.30E+02	J			1.94E+02	J			1.90E+02	J			1.67E+02	J		
Selenium	mg/kg	4.70E-01	3.91E+01	ND				5.40E-01	J	YES		ND				ND			
Thallium	mg/kg	1.40E+00	5.08E-01	5.80E-01	B		YES	1.50E+00	B	YES	YES	6.80E-01	B		YES	9.60E-01	B		YES
Vanadium	mg/kg	6.49E+01	5.31E+01	5.56E+01			YES	7.78E+01		YES	YES	6.11E+01			YES	7.67E+01		YES	YES
Zinc	mg/kg	3.49E+01	2.34E+03	1.00E+02	J	YES		2.84E+02	J	YES		9.87E+01	J	YES		2.81E+02	J	YES	
VOLATILE ORGANIC COMPOUNDS																			
2-Butanone	mg/kg	NA	4.66E+03	ND				ND				ND				ND			
Acetone	mg/kg	NA	7.76E+02	9.20E-03	B			ND				9.00E-03	B			ND			
Bromomethane	mg/kg	NA	1.09E+01	ND				ND				ND				ND			
Carbon tetrachloride	mg/kg	NA	4.83E+00	1.50E-03	J			6.90E-03				7.50E-03				1.30E-02			
Chloroform	mg/kg	NA	1.03E+02	ND				1.70E-03	J			3.10E-03	J			2.70E-03	J		
Cumene	mg/kg	NA	7.77E+02	ND				ND				ND				ND			
Methylene chloride	mg/kg	NA	8.41E+01	4.00E-03	B			3.80E-03	B			3.20E-03	B			2.80E-03	B		
Naphthalene	mg/kg	NA	1.55E+02	ND				1.30E-03	B			ND				ND			
Toluene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.40E-03	B			5.30E-03	J			2.10E-03	B			1.90E-03	B		
p-Cymene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
Benzo(a)anthracene	mg/kg	NA	8.51E-01	NR				NR				NR				NR			
Chrysene	mg/kg	NA	8.61E+01	NR				NR				NR				NR			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	NR				NR				NR				NR			
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	NR				NR				NR				NR			

Table 4-2

**Subsurface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 6 of 10)

Sample Location Sample Number Sample Date Sample Depth (Feet)				RJR-202-GP21 JBB0010 20-Jun-01 11 - 12				RJR-202-GP22 JBB0012 20-Jun-01 11 - 12				RJR-202-GP23 JBB0014 20-Jun-01 11 - 12				RJR-202-GP24 JBB0016 20-Jun-01 11 - 12			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS																			
Aluminum	mg/kg	1.36E+04	7.80E+03	4.89E+03				6.28E+03				7.72E+03				3.75E+03			
Antimony	mg/kg	1.31E+00	3.11E+00	7.90E-01	J			1.10E+00	J			1.30E+00	J			9.70E-01	J		
Arsenic	mg/kg	1.83E+01	4.26E-01	1.77E+01			YES	2.80E+01		YES	YES	3.97E+01		YES	YES	2.22E+01		YES	YES
Barium	mg/kg	2.34E+02	5.47E+02	3.00E+00	J			9.50E+00	J			6.00E+00	J			2.30E+00	J		
Beryllium	mg/kg	8.60E-01	9.60E+00	5.00E-01	J			9.20E-01	J	YES		5.80E-01	J			6.20E-01	J		
Calcium	mg/kg	6.37E+02	NA	1.37E+02	J			2.50E+01	J			7.77E+01	J			2.41E+01	J		
Chromium	mg/kg	3.83E+01	2.32E+01	1.74E+01	J			1.84E+01	J			2.78E+01	J		YES	1.17E+01	J		
Cobalt	mg/kg	1.75E+01	4.68E+02	4.70E+00	J			1.35E+01	J			7.20E+00	J			8.30E+00	J		
Copper	mg/kg	1.94E+01	3.13E+02	1.99E+01	J	YES		3.34E+01	J	YES		3.48E+01	J	YES		2.44E+01	J	YES	
Iron	mg/kg	4.48E+04	2.34E+03	2.28E+04			YES	3.10E+04			YES	4.69E+04		YES	YES	2.17E+04			YES
Lead	mg/kg	3.85E+01	4.00E+02	7.00E+00	J			1.65E+01	J			1.41E+01	J			1.06E+01	J		
Magnesium	mg/kg	7.66E+02	NA	6.92E+01	J			1.20E+02	J			8.81E+01	J			6.63E+01	J		
Manganese	mg/kg	1.36E+03	3.63E+02	5.20E+01	J			2.08E+02	J			9.08E+01	J			9.87E+01	J		
Mercury	mg/kg	7.00E-02	2.33E+00	4.80E-02				5.10E-02				7.50E-02		YES		2.70E-02	J		
Nickel	mg/kg	1.29E+01	1.54E+02	9.30E+00	J			2.19E+01	J	YES		1.53E+01	J	YES		1.46E+01	J	YES	
Potassium	mg/kg	7.11E-02	NA	1.16E-02	J			1.71E+02	J			1.20E+02	J			1.07E+02	J		
Selenium	mg/kg	4.70E-01	3.91E+01	ND				ND				6.60E-01	J	YES		ND			
Thallium	mg/kg	1.40E+00	5.08E-01	6.50E-01	B		YES	6.30E-01	B		YES	7.50E-01	B		YES	6.70E-01	B		YES
Vanadium	mg/kg	6.49E+01	5.31E+01	4.39E+01				5.32E+01			YES	8.79E+01		YES	YES	3.63E+01			
Zinc	mg/kg	3.49E+01	2.34E+03	6.62E+01	J	YES		1.36E+02	J	YES		9.26E+01	J	YES		9.32E+01	J	YES	
VOLATILE ORGANIC COMPOUNDS																			
2-Butanone	mg/kg	NA	4.66E+03	ND				ND				ND				ND			
Acetone	mg/kg	NA	7.76E+02	8.30E-03	B			9.40E-03	B			ND				ND			
Bromomethane	mg/kg	NA	1.09E+01	ND				ND				ND				ND			
Carbon tetrachloride	mg/kg	NA	4.83E+00	1.30E-02				ND				ND				ND			
Chloroform	mg/kg	NA	1.03E+02	3.10E-03	J			ND				ND				ND			
Cumene	mg/kg	NA	7.77E+02	ND				ND				ND				ND			
Methylene chloride	mg/kg	NA	8.41E+01	2.90E-03	B			3.00E-03	B			2.90E-03	B			2.00E-03	B		
Naphthalene	mg/kg	NA	1.55E+02	ND				ND				ND				ND			
Toluene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
Trichlorofluoromethane	mg/kg	NA	2.33E+03	1.80E-03	B			1.70E-03	B			1.20E-03	J			1.20E-03	J		
p-Cymene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
Benzo(a)anthracene	mg/kg	NA	8.51E-01	NR				NR				NR				NR			
Chrysene	mg/kg	NA	8.61E-01	NR				NR				NR				NR			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	NR				NR				NR				NR			
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	NR				NR				NR				NR			

Table 4-2

**Subsurface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 7 of 10)

Sample Location Sample Number Sample Date Sample Depth (Feet)				RJR-202-MW04 JB0049 8-Jan-99 2 - 4				RJR-202-MW05 JB0051 11-Jan-99 6 - 8				RJR-202-MW06 JB0067 15-Jan-99 54- 56				RJR-202-MW06 JB0053 25-Feb-99 8 - 10			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS																			
Aluminum	mg/kg	1.36E+04	7.80E+03	NR				NR				NR				NR			
Antimony	mg/kg	1.31E+00	3.11E+00	NR				NR				NR				NR			
Arsenic	mg/kg	1.83E+01	4.26E-01	NR				NR				NR				NR			
Barium	mg/kg	2.34E+02	5.47E+02	NR				NR				NR				NR			
Beryllium	mg/kg	8.60E-01	9.60E+00	NR				NR				NR				NR			
Calcium	mg/kg	6.37E+02	NA	NR				NR				NR				NR			
Chromium	mg/kg	3.83E+01	2.32E+01	NR				NR				NR				NR			
Cobalt	mg/kg	1.75E+01	4.68E+02	NR				NR				NR				NR			
Copper	mg/kg	1.94E+01	3.13E+02	NR				NR				NR				NR			
Iron	mg/kg	4.48E+04	2.34E+03	NR				NR				NR				NR			
Lead	mg/kg	3.85E+01	4.00E+02	NR				NR				NR				NR			
Magnesium	mg/kg	7.66E+02	NA	NR				NR				NR				NR			
Manganese	mg/kg	1.36E+03	3.63E+02	NR				NR				NR				NR			
Mercury	mg/kg	7.00E-02	2.33E+00	NR				NR				NR				NR			
Nickel	mg/kg	1.29E+01	1.54E+02	NR				NR				NR				NR			
Potassium	mg/kg	7.11E+02	NA	NR				NR				NR				NR			
Selenium	mg/kg	4.70E-01	3.91E+01	NR				NR				NR				NR			
Thallium	mg/kg	1.40E+00	5.08E-01	NR				NR				NR				NR			
Vanadium	mg/kg	6.49E+01	5.31E+01	NR				NR				NR				NR			
Zinc	mg/kg	3.49E+01	2.34E+03	NR				NR				NR				NR			
VOLATILE ORGANIC COMPOUNDS																			
2-Butanone	mg/kg	NA	4.66E+03	ND				ND				ND				ND			
Acetone	mg/kg	NA	7.76E+02	8.30E-03	B			5.20E-01	J			1.10E-02	B			ND			
Bromomethane	mg/kg	NA	1.09E+01	2.60E-03	B			1.70E-03	B			2.40E-03	B			ND			
Carbon tetrachloride	mg/kg	NA	4.83E+00	ND				ND				ND				ND			
Chloroform	mg/kg	NA	1.03E+02	ND				ND				ND				ND			
Cumene	mg/kg	NA	7.77E+02	ND				4.30E-03	J			ND				ND			
Methylene chloride	mg/kg	NA	8.41E+01	4.90E-03	B			3.00E-03	B			5.30E-03	B			4.60E-03	B		
Naphthalene	mg/kg	NA	1.55E+02	ND				ND				ND				ND			
Toluene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
Trichlorofluoromethane	mg/kg	NA	2.33E+03	ND				ND				ND				3.80E-03	J		
p-Cymene	mg/kg	NA	1.55E+03	ND				3.80E-03	J			ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
Benzo(a)anthracene	mg/kg	NA	8.51E-01	ND				ND				ND				ND			
Chrysene	mg/kg	NA	8.61E+01	ND				ND				ND				ND			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	ND				ND				7.70E-02	B			ND			
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	ND				ND				7.40E-02	B			ND			

Table 4-2

**Subsurface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

(Page 8 of 10)

Sample Location Sample Number Sample Date Sample Depth (Feet)				RJR-202-MW07 JB0055 26-Jan-99 10 - 12				RJR-202-MW08 JB0058 18-Jan-99 1 - 3				RJR-202-MW09 JB0060 19-Jan-99 10 - 12				RJR-202-MW10 JB0062 21-Jan-99 10 - 12			
Parameter	Units	BKG ^a	SSSL ^a	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS																			
Aluminum	mg/kg	1.36E+04	7.80E+03	NR				NR				NR				NR			
Antimony	mg/kg	1.31E+00	3.11E+00	NR				NR				NR				NR			
Arsenic	mg/kg	1.83E+01	4.26E-01	NR				NR				NR				NR			
Barium	mg/kg	2.34E+02	5.47E+02	NR				NR				NR				NR			
Beryllium	mg/kg	8.60E-01	9.60E+00	NR				NR				NR				NR			
Calcium	mg/kg	6.37E+02	NA	NR				NR				NR				NR			
Chromium	mg/kg	3.83E+01	2.32E+01	NR				NR				NR				NR			
Cobalt	mg/kg	1.75E+01	4.68E+02	NR				NR				NR				NR			
Copper	mg/kg	1.94E+01	3.13E+02	NR				NR				NR				NR			
Iron	mg/kg	4.48E+04	2.34E+03	NR				NR				NR				NR			
Lead	mg/kg	3.85E+01	4.00E+02	NR				NR				NR				NR			
Magnesium	mg/kg	7.66E+02	NA	NR				NR				NR				NR			
Manganese	mg/kg	1.36E+03	3.63E+02	NR				NR				NR				NR			
Mercury	mg/kg	7.00E-02	2.33E+00	NR				NR				NR				NR			
Nickel	mg/kg	1.29E+01	1.54E+02	NR				NR				NR				NR			
Potassium	mg/kg	7.11E+02	NA	NR				NR				NR				NR			
Selenium	mg/kg	4.70E-01	3.91E+01	NR				NR				NR				NR			
Thallium	mg/kg	1.40E+00	5.08E-01	NR				NR				NR				NR			
Vanadium	mg/kg	6.49E+01	5.31E+01	NR				NR				NR				NR			
Zinc	mg/kg	3.49E+01	2.34E+03	NR				NR				NR				NR			
VOLATILE ORGANIC COMPOUNDS																			
2-Butanone	mg/kg	NA	4.66E+03	ND				ND				ND				ND			
Acetone	mg/kg	NA	7.76E+02	6.50E-02 J				9.70E-02 J				4.40E-02 B				1.60E-01 J			
Bromomethane	mg/kg	NA	1.09E+01	ND				9.30E-03 B				1.10E-02 B				ND			
Carbon tetrachloride	mg/kg	NA	4.83E+00	ND				ND				ND				ND			
Chloroform	mg/kg	NA	1.03E+02	ND				ND				ND				ND			
Cumene	mg/kg	NA	7.77E+02	ND				ND				ND				ND			
Methylene chloride	mg/kg	NA	8.41E+01	5.50E-03 B				1.80E-02 B				1.90E-02 B				2.10E-02 J			
Naphthalene	mg/kg	NA	1.55E+02	ND				ND				ND				3.00E-02 J			
Toluene	mg/kg	NA	1.55E+03	ND				ND				ND				ND			
Trichlorofluoromethane	mg/kg	NA	2.33E+03	5.80E-03 J				ND				ND				ND			
p-Cymene	mg/kg	NA	1.55E+03	ND				3.50E-02				ND				7.40E-02			
SEMIVOLATILE ORGANIC COMPOUNDS																			
Benzo(a)anthracene	mg/kg	NA	8.51E-01	ND				ND				ND				ND			
Chrysene	mg/kg	NA	8.61E+01	ND				ND				ND				ND			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	ND				ND				ND				ND			
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	ND				ND				ND				ND			

Table 4-2

Subsurface Soil Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 9 of 10)

Sample Location Sample Number Sample Date Sample Depth (Feet)				RJR-202-MW10 JB0068 22-Jan-99 19- 21				RJR-202-MW12 JB0064 27-Jan-99 10 - 12			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS											
Aluminum	mg/kg	1.36E+04	7.80E+03	NR				NR			
Antimony	mg/kg	1.31E+00	3.11E+00	NR				NR			
Arsenic	mg/kg	1.83E+01	4.26E-01	NR				NR			
Barium	mg/kg	2.34E+02	5.47E+02	NR				NR			
Beryllium	mg/kg	8.60E-01	9.60E+00	NR				NR			
Calcium	mg/kg	6.37E+02	NA	NR				NR			
Chromium	mg/kg	3.83E+01	2.32E+01	NR				NR			
Cobalt	mg/kg	1.75E+01	4.68E+02	NR				NR			
Copper	mg/kg	1.94E+01	3.13E+02	NR				NR			
Iron	mg/kg	4.48E+04	2.34E+03	NR				NR			
Lead	mg/kg	3.85E+01	4.00E+02	NR				NR			
Magnesium	mg/kg	7.66E+02	NA	NR				NR			
Manganese	mg/kg	1.36E+03	3.63E+02	NR				NR			
Mercury	mg/kg	7.00E-02	2.33E+00	NR				NR			
Nickel	mg/kg	1.29E+01	1.54E+02	NR				NR			
Potassium	mg/kg	7.11E+02	NA	NR				NR			
Selenium	mg/kg	4.70E-01	3.91E+01	NR				NR			
Thallium	mg/kg	1.40E+00	5.08E-01	NR				NR			
Vanadium	mg/kg	6.49E+01	5.31E+01	NR				NR			
Zinc	mg/kg	3.49E+01	2.34E+03	NR				NR			
VOLATILE ORGANIC COMPOUNDS											
2-Butanone	mg/kg	NA	4.66E+03	ND				5.50E-03	J		
Acetone	mg/kg	NA	7.76E+02	1.50E-02	J			1.80E-01	J		
Bromomethane	mg/kg	NA	1.09E+01	ND				ND			
Carbon tetrachloride	mg/kg	NA	4.83E+00	4.10E-03	J			ND			
Chloroform	mg/kg	NA	1.03E+02	ND				ND			
Cumene	mg/kg	NA	7.77E+02	ND				4.10E-03	J		
Methylene chloride	mg/kg	NA	8.41E+01	2.70E-03	B			2.80E-03	B		
Naphthalene	mg/kg	NA	1.55E+02	ND				ND			
Toluene	mg/kg	NA	1.55E+03	2.10E-03	J			ND			
Trichlorofluoromethane	mg/kg	NA	2.33E+03	3.00E-03	J			ND			
p-Cymene	mg/kg	NA	1.55E+03	ND				6.20E-03			
SEMIVOLATILE ORGANIC COMPOUNDS											
Benzo(a)anthracene	mg/kg	NA	8.51E-01	5.00E-02	J			ND			
Chrysene	mg/kg	NA	8.61E+01	7.50E-02	J			ND			
Di-n-butyl phthalate	mg/kg	NA	7.80E+02	ND				ND			
bis(2-Ethylhexyl)phthalate	mg/kg	NA	4.52E+01	ND				7.40E-02	J		

Table 4-2

Subsurface Soil Analytical Results Range J - Pelham Range, Parcel 202(7) Fort McClellan, Calhoun County, Alabama

(Page 10 of 10)

Analyses performed using U.S. Environmental Protection Agency (EPA) SW-846 analytical methods.

^a BKG - Background. Concentration listed is two times (2x) the arithmetic mean of background metals concentration given in SAIC, 1998, *Final Background Metals Survey Report, Fort McClellan, Alabama*, July.

^b Residential human health site-specific screening level (SSSL) as given in IT Corporation (2000), *Final Human Health and Ecological Screening Values and PAH Background Summary Report, Fort McClellan, Calhoun County, Alabama*, July.

B - Analyte detected in laboratory or field blank at concentration greater than the reporting limit (and greater than zero).

J - Compound was positively identified; reported value is an estimated concentration.

mg/kg - Milligrams per kilogram.

NA - Not available.

ND - Not detected.

NR - Not requested.

Qual - Data validation qualifier.

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 1 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW01 JB3001 15-Apr-99				RJR-202-MW01 JB3019 18-May-01				RJR-202-MW02 JB3002 16-Apr-99				RJR-202-MW02 JB3020 24-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				ND				NR				ND			
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				4.47E-03	J			NR				4.22E-03	J		
Calcium	mg/L	5.65E+01	NA	NR				2.22E+01	J			NR				1.93E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.30E+01				NR				1.15E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				ND				NR				ND			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				2.01E-03	B		
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				7.62E-01	J			NR				1.25E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				1.43E-02	J			NR				ND			
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				1.38E-01	J			NR				1.66E-01	J		
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				7.72E-03	J			NR				6.38E-03	J		
Beryllium	mg/L	1.25E-03	3.13E-03	NR				ND				NR				ND			
Calcium	mg/L	5.65E+01	NA	NR				2.43E+01				NR				1.92E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				2.33E-01				NR				3.66E-01			
Lead	mg/L	8.00E-03	1.50E-02	NR				1.54E-03	J			NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.30E+01				NR				1.16E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				9.35E-03	J			NR				1.62E-02			
Nickel	mg/L	NA	3.13E-02	NR				ND				NR				1.14E-02	J		
Potassium	mg/L	7.20E+00	NA	NR				ND				NR				ND			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				7.76E-01	J			NR				1.26E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				1.64E-02	J			NR				ND			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 2 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW01 JB3001 15-Apr-99				RJR-202-MW01 JB3019 18-May-01				RJR-202-MW02 JB3002 16-Apr-99				RJR-202-MW02 JB3020 24-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND				ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	ND				ND				2.80E-03	B			ND			
Benzene	mg/L	NA	1.41E-03	ND				ND				ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				ND				ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	2.60E-02			YES	6.20E-02			YES	1.40E-03			YES	3.00E-03	J		YES
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	4.30E-04	J			ND				1.00E-03				1.10E-03	B		
Chloromethane	mg/L	NA	3.93E-03	ND				ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				ND				ND				ND			
Tetrachloroethene	mg/L	NA	1.26E-03	*ND				ND				ND				ND			
Toluene	mg/L	NA	2.59E-01	ND				ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	6.80E-04	J			ND				4.50E-03				4.10E-03	J		
p-Cymene	mg/L	NA	2.26E-01	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	ND				NR				ND				NR			
Phenol	mg/L	NA	9.31E-01	ND				NR				ND				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	ND				NR				ND				NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	NR				ND				NR				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	NR				3.52E-01				NR				3.75E-01			
Sulfate	mg/L	NA	NA	NR				9.15E-01				NR				8.21E-01			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 3 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW03 JB3003 19-Apr-99				RJR-202-MW03 JB3021 30-May-01				RJR-202-MW04 JB3006 19-Apr-99				RJR-202-MW04 JB3024 17-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				ND				NR				ND			
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				2.23E-03	J			NR				5.82E-03	J		
Calcium	mg/L	5.65E+01	NA	NR				1.65E+01	J			NR				2.44E+01	J		
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				9.76E+00	J			NR				1.44E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				ND				NR				ND			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				1.73E-03	J		
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				1.11E+00				NR				1.19E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				ND			
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				9.51E-02	J			NR				ND			
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				2.81E-03	J			NR				5.71E-03	J		
Beryllium	mg/L	1.25E-03	3.13E-03	NR				ND				NR				ND			
Calcium	mg/L	5.65E+01	NA	NR				1.65E+01	J			NR				2.49E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				3.93E-02	J			NR				5.03E-02	B		
Lead	mg/L	8.00E-03	1.50E-02	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				9.60E+00	J			NR				1.49E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				4.52E-03	J			NR				4.66E-03	J		
Nickel	mg/L	NA	3.13E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				ND				NR				ND			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				1.16E+00				NR				1.22E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				ND			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 4 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW03 JB3003 19-Apr-99				RJR-202-MW03 JB3021 30-May-01				RJR-202-MW04 JB3006 19-Apr-99				RJR-202-MW04 JB3024 17-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	1.00E-03			YES	ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND				ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	1.60E-03	B			ND				ND				ND			
Benzene	mg/L	NA	1.41E-03	ND				ND				ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				1.70E-04	B			ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	7.30E-01			YES	9.70E-01			YES	ND				ND			
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	8.90E-03	B		YES	1.10E-02	B		YES	1.80E-04	B			ND			
Chloromethane	mg/L	NA	3.93E-03	ND				ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				1.60E-04	J			ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				ND				ND				ND			
Tetrachloroethene	mg/L	NA	1.26E-03	2.40E-03			YES	2.70E-03	J		YES	ND				ND			
Toluene	mg/L	NA	2.59E-01	ND				ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	1.20E-03				ND				ND				ND			
p-Cymene	mg/L	NA	2.26E-01	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	ND				NR				ND				NR			
Phenol	mg/L	NA	9.31E-01	ND				NR				ND				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	ND				NR				ND				NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	NR				ND				NR				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	NR				3.17E-01				NR				1.62E-01			
Sulfate	mg/L	NA	NA	NR				1.83E+00				NR				1.36E+00			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 5 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW05 JB3007 19-Apr-99				RJR-202-MW05 JB3025 17-May-01				RJR-202-MW06 JB3008 21-Apr-99				RJR-202-MW06 JB3026 16-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				ND				NR				ND			
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				1.69E-02				NR				2.06E-02			
Calcium	mg/L	5.65E+01	NA	NR				1.92E+01	J			NR				2.20E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.17E+01				NR				1.43E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				ND				NR				1.18E+01		YES	
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				1.92E+00				NR				5.03E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				ND			
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				ND				NR				9.60E-02	B		
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				1.51E-02				NR				2.94E-02			
Beryllium	mg/L	1.25E-03	3.13E-03	NR				ND				NR				ND			
Calcium	mg/L	5.65E+01	NA	NR				1.67E+01				NR				1.93E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				2.25E-02	B			NR				6.58E-02	J		
Lead	mg/L	8.00E-03	1.50E-02	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.02E+01				NR				1.11E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				3.73E-03	J			NR				4.41E-03	J		
Nickel	mg/L	NA	3.13E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				ND				NR				3.40E+01		YES	
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				8.97E-03	B	YES	YES
Sodium	mg/L	1.48E+01	NA	NR				1.68E+00				NR				1.37E+01			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				5.42E-03	B		
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				7.07E-03	J		

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 6 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW05 JB3007 19-Apr-99				RJR-202-MW05 JB3025 17-May-01				RJR-202-MW06 JB3008 21-Apr-99				RJR-202-MW06 JB3026 16-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND				ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	1.40E-03	J			ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	ND				ND				ND				ND			
Benzene	mg/L	NA	1.41E-03	ND				ND				ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				ND				ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	1.00E-03			YES	ND				ND				ND			
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	5.30E-04	B			ND				2.20E-04	B			ND			
Chloromethane	mg/L	NA	3.93E-03	ND				ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				ND				ND				ND			
Tetrachloroethene	mg/L	NA	1.26E-03	ND				ND				ND				ND			
Toluene	mg/L	NA	2.59E-01	ND				ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	ND				ND				ND				ND			
p-Cymene	mg/L	NA	2.26E-01	1.20E-03				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	ND				NR				ND				NR			
Phenol	mg/L	NA	9.31E-01	ND				NR				ND				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	ND				NR				ND				NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	NR				ND				NR				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	NR				1.70E-01				NR				2.75E-01			
Sulfate	mg/L	NA	NA	NR				3.95E+00				NR				1.39E+00			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 7 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW07 JB3009 27-Apr-99				RJR-202-MW07 JB3027 17-May-01				RJR-202-MW08 JB3010 27-Apr-99				RJR-202-MW08 JB3028 23-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				ND				NR				ND			
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				3.58E-03	J			NR				4.52E-03	J		
Calcium	mg/L	5.65E+01	NA	NR				1.19E+01	J			NR				9.75E+00			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.37E+01				NR				1.32E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				2.72E+01		YES		NR				2.32E+01		YES	
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				8.53E+00				NR				7.37E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				ND			
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				ND				NR				ND			
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				9.85E-03	J			NR				5.01E-03	J		
Beryllium	mg/L	1.25E-03	3.13E-03	NR				ND				NR				ND			
Calcium	mg/L	5.65E+01	NA	NR				1.73E+01				NR				1.06E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				5.94E-02	B			NR				ND			
Lead	mg/L	8.00E-03	1.50E-02	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.68E+01				NR				1.41E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				9.84E-03	J			NR				ND			
Nickel	mg/L	NA	3.13E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				2.85E+01		YES		NR				2.46E+01		YES	
Selenium	mg/L	NA	7.82E-03	NR				3.53E-03	J			NR				2.60E-03	B		
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				8.80E+00				NR				7.74E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				6.37E-03	J		

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 8 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW07 JB3009 27-Apr-99				RJR-202-MW07 JB3027 17-May-01				RJR-202-MW08 JB3010 27-Apr-99				RJR-202-MW08 JB3028 23-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND				ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	ND				ND				1.10E-03	B			ND			
Benzene	mg/L	NA	1.41E-03	ND				ND				ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				ND				ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	9.70E-04	B		YES	ND				1.50E-03	B		YES	ND			
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	5.80E-04	B			ND				ND				ND			
Chloromethane	mg/L	NA	3.93E-03	ND				ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				ND				ND				ND			
Tetrachloroethene	mg/L	NA	1.26E-03	ND				ND				ND				ND			
Toluene	mg/L	NA	2.59E-01	ND				ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	4.60E-04	B			ND				1.30E-04	B			ND			
p-Cymene	mg/L	NA	2.26E-01	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	ND				NR				ND				NR			
Phenol	mg/L	NA	9.31E-01	ND				NR				ND				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	ND				NR				ND				NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	NR				ND				NR				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	NR				3.99E-01				NR				5.02E-01			
Sulfate	mg/L	NA	NA	NR				3.66E+00				NR				9.72E+00			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 9 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW09 JB3011 26-Apr-99				RJR-202-MW09 JB3029 29-May-01				RJR-202-MW10 JB3012 29-Apr-99				RJR-202-MW10 JB3030 30-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				ND				NR				5.08E-02	J		
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				8.86E-03	J			NR				3.97E-03	J		
Calcium	mg/L	5.65E+01	NA	NR				1.83E+01				NR				2.24E+01	J		
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.47E+01				NR				2.37E+01	J	YES	
Manganese	mg/L	5.81E-01	7.35E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				4.33E+00	J			NR				6.06E+00			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				3.99E+00				NR				3.52E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				7.85E-03	J		
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				4.74E-02	J			NR				ND			
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				9.70E-03	J			NR				4.46E-03	J		
Beryllium	mg/L	1.25E-03	3.13E-03	NR				ND				NR				ND			
Calcium	mg/L	5.65E+01	NA	NR				1.92E+01				NR				2.36E+01	J		
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				3.65E-02	J			NR				ND			
Lead	mg/L	8.00E-03	1.50E-02	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.50E+01				NR				2.43E+01	J	YES	
Manganese	mg/L	5.81E-01	7.35E-02	NR				5.09E-03	J			NR				ND			
Nickel	mg/L	NA	3.13E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				4.04E+00	J			NR				4.96E+00	J		
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				4.43E+00				NR				3.41E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				ND			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 10 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW09 JB3011 26-Apr-99				RJR-202-MW09 JB3029 29-May-01				RJR-202-MW10 JB3012 29-Apr-99				RJR-202-MW10 JB3030 30-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND				ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	2.20E-03	B			ND				5.40E-03	B			ND			
Benzene	mg/L	NA	1.41E-03	ND				ND				ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				ND				ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	2.60E-02			YES	3.00E-02			YES	2.80E+00			YES	4.10E+00			YES
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	1.50E-03	B		YES	1.30E-03	B		YES	1.20E-01			YES	5.00E-02			YES
Chloromethane	mg/L	NA	3.93E-03	ND				ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				2.20E-03	B			3.30E-03	B			2.80E-03	B		
Tetrachloroethene	mg/L	NA	1.26E-03	1.10E-04	J			ND				9.00E-03			YES	9.40E-03			YES
Toluene	mg/L	NA	2.59E-01	ND				ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	2.40E-04	B			ND				1.30E-03	B			9.60E-04	J		
p-Cymene	mg/L	NA	2.26E-01	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	ND				NR				ND				NR			
Phenol	mg/L	NA	9.31E-01	ND				NR				ND				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	1.10E-03	B			NR				ND				NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	NR				ND				NR				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	NR				3.39E-01				NR				2.95E-01			
Sulfate	mg/L	NA	NA	NR				2.36E+00				NR				2.61E+00			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 11 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW11 JB3013 28-Apr-99				RJR-202-MW11 JB3031 30-May-01				RJR-202-MW12 JB3014 28-Apr-99				RJR-202-MW12 JB3032 29-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				1.36E-01	J			NR				4.64E-02	J		
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				5.53E-03	J			NR				4.91E-03	J		
Calcium	mg/L	5.65E+01	NA	NR				2.86E+01	J			NR				2.08E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.72E+01	J			NR				1.25E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				1.76E-03	J			NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				ND				NR				ND			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				1.19E+00				NR				1.05E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				ND			
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				ND				NR				1.17E-01	J		
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				5.91E-03	J			NR				4.43E-03	J		
Beryllium	mg/L	1.25E-03	3.13E-03	NR				ND				NR				ND			
Calcium	mg/L	5.65E+01	NA	NR				3.07E+01	J			NR				2.06E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				2.78E-03	B		
Iron	mg/L	7.04E+00	4.69E-01	NR				ND				NR				4.75E-02	J		
Lead	mg/L	8.00E-03	1.50E-02	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.85E+01	J			NR				1.25E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				1.75E-03	J			NR				2.01E-03	J		
Nickel	mg/L	NA	3.13E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				ND				NR				ND			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				1.22E+00				NR				1.05E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				ND			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 12 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW11 JB3013 28-Apr-99				RJR-202-MW11 JB3031 30-May-01				RJR-202-MW12 JB3014 28-Apr-99				RJR-202-MW12 JB3032 29-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	1.60E-04	J			ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				3.20E-02			YES	ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	3.00E-04	J			ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	2.70E-03	B			ND				ND				ND			
Benzene	mg/L	NA	1.41E-03	3.50E+00			YES	2.20E+00			YES	ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				1.40E-04	J			ND			
Carbon disulfide	mg/L	NA	1.51E-01	2.30E-03				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	1.10E+01			YES	1.00E+01			YES	2.20E-03	B		YES	2.50E-03	J		YES
Chlorobenzene	mg/L	NA	1.62E-02	9.30E-04	J			ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	1.30E-01	J		YES	6.80E-02			YES	5.00E-04	B			ND			
Chloromethane	mg/L	NA	3.93E-03	3.70E-04	J			ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	1.20E-03	B			1.70E-03	J			ND				2.00E-03	B		
Tetrachloroethene	mg/L	NA	1.26E-03	1.70E-02			YES	1.40E-02			YES	ND				ND			
Toluene	mg/L	NA	2.59E-01	8.70E-04	J			ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	3.10E-03	B			1.50E-03	J			1.10E-03	B			1.50E-03	J		
p-Cymene	mg/L	NA	2.26E-01	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	1.80E-03	J			NR				ND				NR			
Phenol	mg/L	NA	9.31E-01	2.50E-02	J			NR				ND				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	3.10E-03	B			NR				1.80E-03	B			NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	NR				ND				NR				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	NR				9.00E-02	J			NR				2.97E-01			
Sulfate	mg/L	NA	NA	NR				1.10E+00				NR				2.01E+00			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 13 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW13 JB3015 20-Apr-99				RJR-202-MW13 JB3033 21-May-01				RJR-202-MW14 JB3016 27-Apr-99				RJR-202-MW14 JB3034 23-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				ND				NR				ND			
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				3.43E-03	J			NR				7.76E-03	J		
Calcium	mg/L	5.65E+01	NA	NR				1.56E+01				NR				2.93E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				ND				NR				1.47E-02	J		
Magnesium	mg/L	2.13E+01	NA	NR				1.11E+01				NR				1.76E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				6.25E+00				NR				ND			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				1.87E+00				NR				4.20E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				7.40E-03	J			NR				ND			
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				1.87E-01	J			NR				ND			
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				4.43E-03	J			NR				7.46E-03	J		
Beryllium	mg/L	1.25E-03	3.13E-03	NR				ND				NR				ND			
Calcium	mg/L	5.65E+01	NA	NR				1.65E+01				NR				2.90E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				5.92E-01			YES	NR				ND			
Lead	mg/L	8.00E-03	1.50E-02	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.26E+01				NR				1.73E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				2.14E-02				NR				ND			
Nickel	mg/L	NA	3.13E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				8.44E+00	B	YES		NR				ND			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				2.26E+00				NR				4.20E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				1.73E-02	J			NR				ND			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 14 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW13 JB3015 20-Apr-99				RJR-202-MW13 JB3033 21-May-01				RJR-202-MW14 JB3016 27-Apr-99				RJR-202-MW14 JB3034 23-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND				ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	ND				ND				ND				ND			
Benzene	mg/L	NA	1.41E-03	ND				ND				ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				ND				ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	ND				2.00E-03	J		YES	2.60E-03	B		YES	1.40E-03	J		YES
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	ND				ND				8.60E-04	B			ND			
Chloromethane	mg/L	NA	3.93E-03	ND				ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				ND				ND				ND			
Tetrachloroethene	mg/L	NA	1.26E-03	ND				ND				ND				ND			
Toluene	mg/L	NA	2.59E-01	ND				ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	ND				ND				5.00E-04	B			ND			
p-Cymene	mg/L	NA	2.26E-01	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	ND				NR				ND				NR			
Phenol	mg/L	NA	9.31E-01	ND				NR				ND				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	ND				NR				2.70E-03	B			NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	NR				ND				NR				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	NR				2.34E-01				NR				3.40E-02	J		
Sulfate	mg/L	NA	NA	NR				1.29E+00				NR				2.76E+00			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 15 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW15 JB3017 26-Apr-99				RJR-202-MW15 JB3035 15-May-01				RJR-202-MW16 JB3018 20-Apr-99				RJR-202-MW16 JB3036 16-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				ND				NR				ND			
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				ND			
Barium	mg/L	1.27E-01	1.10E-01	NR				5.43E-03	J			NR				5.86E-03	J		
Calcium	mg/L	5.65E+01	NA	NR				2.10E+01				NR				2.03E+01			
Chromium	mg/L	NA	4.69E-03	NR				ND				NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.56E+01				NR				1.21E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				8.50E+00		YES		NR				ND			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				4.63E-03	B	YES		NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				5.15E+00				NR				9.85E-01	J		
Vanadium	mg/L	1.70E-02	1.10E-02	NR				ND				NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				ND				NR				ND			
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	NR				3.92E-01				NR				1.46E-01	J		
Antimony	mg/L	3.19E-03	6.25E-04	NR				ND				NR				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	NR				ND				NR				2.48E-03	J		YES
Barium	mg/L	1.27E-01	1.10E-01	NR				1.04E-02				NR				7.03E-03	J		
Beryllium	mg/L	1.25E-03	3.13E-03	NR				ND				NR				ND			
Calcium	mg/L	5.65E+01	NA	NR				2.53E+01				NR				2.12E+01			
Chromium	mg/L	NA	4.69E-03	NR				5.59E-03	J		YES	NR				ND			
Copper	mg/L	2.55E-02	6.26E-02	NR				ND				NR				ND			
Iron	mg/L	7.04E+00	4.69E-01	NR				4.65E-01				NR				1.08E-01	J		
Lead	mg/L	8.00E-03	1.50E-02	NR				ND				NR				ND			
Magnesium	mg/L	2.13E+01	NA	NR				1.77E+01				NR				1.27E+01			
Manganese	mg/L	5.81E-01	7.35E-02	NR				4.30E-02				NR				4.10E-03	J		
Nickel	mg/L	NA	3.13E-02	NR				ND				NR				ND			
Potassium	mg/L	7.20E+00	NA	NR				7.18E+00				NR				ND			
Selenium	mg/L	NA	7.82E-03	NR				ND				NR				ND			
Silver	mg/L	4.00E-03	7.82E-03	NR				ND				NR				ND			
Sodium	mg/L	1.48E+01	NA	NR				5.75E+00				NR				9.70E-01	J		
Vanadium	mg/L	1.70E-02	1.10E-02	NR				5.41E-03	B			NR				ND			
Zinc	mg/L	2.20E-01	4.69E-01	NR				1.28E-02	J			NR				ND			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 16 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW15 JB3017 26-Apr-99				RJR-202-MW15 JB3035 15-May-01				RJR-202-MW16 JB3018 20-Apr-99				RJR-202-MW16 JB3036 16-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND				ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	1.20E-03	B			ND				ND				ND			
Benzene	mg/L	NA	1.41E-03	ND				ND				ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				ND				ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	ND				ND				3.60E-04	J			ND			
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	4.80E-04	B			ND				ND				ND			
Chloromethane	mg/L	NA	3.93E-03	ND				ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				ND				ND				ND			
Tetrachloroethene	mg/L	NA	1.26E-03	ND				ND				ND				ND			
Toluene	mg/L	NA	2.59E-01	ND				ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	ND				ND				ND				ND			
p-Cymene	mg/L	NA	2.26E-01	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	ND				NR				ND				NR			
Phenol	mg/L	NA	9.31E-01	ND				NR				ND				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	9.40E-03	B		YES	NR				ND				NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	NR				ND				NR				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	NR				3.86E-01				NR				3.17E-01			
Sulfate	mg/L	NA	NA	NR				4.47E+00				NR				1.13E+00			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 17 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW18 JB3040 23-May-01				RJR-202-MW20 JB3042 29-May-01				RJR-202-MW22 JB3044 25-May-01				RJR-202-MW25 JB3047 15-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	ND				ND				5.21E-02	J			8.11E-01			
Antimony	mg/L	3.19E-03	6.25E-04	ND				ND				ND				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	ND				4.45E-03	B		YES	ND				2.69E-03	J		YES
Barium	mg/L	1.27E-01	1.10E-01	6.19E-03	J			1.04E-02				1.61E-02				5.12E-02			
Calcium	mg/L	5.65E+01	NA	2.64E+01				2.38E+01				2.09E+01				1.12E+01			
Chromium	mg/L	NA	4.69E-03	ND				ND				ND				ND			
Copper	mg/L	2.55E-02	6.26E-02	ND				ND				3.70E-03	B			ND			
Iron	mg/L	7.04E+00	4.69E-01	ND				2.15E-02	J			2.59E-02	J			4.99E-01			YES
Magnesium	mg/L	2.13E+01	NA	1.60E+01				1.49E+01				1.30E+01				4.49E+00			
Manganese	mg/L	5.81E-01	7.35E-02	ND				3.89E-03	J			1.27E-01			YES	9.11E-03	J		
Potassium	mg/L	7.20E+00	NA	ND				ND				ND				2.80E+01		YES	
Selenium	mg/L	NA	7.82E-03	ND				ND				ND				ND			
Silver	mg/L	4.00E-03	7.82E-03	ND				ND				ND				4.80E-03	B	YES	
Sodium	mg/L	1.48E+01	NA	8.40E-01	J			8.40E-01	J			1.71E+00				1.03E+01			
Vanadium	mg/L	1.70E-02	1.10E-02	ND				ND				ND				5.50E-03	B		
Zinc	mg/L	2.20E-01	4.69E-01	ND				ND				ND				8.78E-03	J		
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	ND				1.31E-01	J			ND				2.82E+00		YES	YES
Antimony	mg/L	3.19E-03	6.25E-04	ND				ND				ND				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	ND				2.63E-03	B		YES	2.69E-03	B		YES	4.04E-03	J		YES
Barium	mg/L	1.27E-01	1.10E-01	6.28E-03	J			1.11E-02				1.59E-02				3.47E-02			
Beryllium	mg/L	1.25E-03	3.13E-03	ND				ND				ND				8.40E-04	B		
Calcium	mg/L	5.65E+01	NA	2.62E+01				2.44E+01				2.02E+01				1.16E+01			
Chromium	mg/L	NA	4.69E-03	ND				ND				ND				ND			
Copper	mg/L	2.55E-02	6.26E-02	ND				ND				ND				ND			
Iron	mg/L	7.04E+00	4.69E-01	ND				2.47E-01				8.95E-02	J			2.01E+00			YES
Lead	mg/L	8.00E-03	1.50E-02	ND				ND				ND				1.46E-03	B		
Magnesium	mg/L	2.13E+01	NA	1.59E+01				1.54E+01				1.27E+01				4.85E+00			
Manganese	mg/L	5.81E-01	7.35E-02	ND				1.98E-02				1.32E-01			YES	7.74E-02			YES
Nickel	mg/L	NA	3.13E-02	ND				ND				ND				ND			
Potassium	mg/L	7.20E+00	NA	ND				ND				ND				2.87E+01		YES	
Selenium	mg/L	NA	7.82E-03	2.03E-03	B			ND				ND				ND			
Silver	mg/L	4.00E-03	7.82E-03	ND				ND				ND				ND			
Sodium	mg/L	1.48E+01	NA	8.40E-01	J			9.02E-01	J			1.70E+00				1.03E+01			
Vanadium	mg/L	1.70E-02	1.10E-02	ND				ND				ND				7.29E-03	B		
Zinc	mg/L	2.20E-01	4.69E-01	ND				ND				8.16E-03	J			3.26E-02			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 18 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW18 JB3040 23-May-01				RJR-202-MW20 JB3042 29-May-01				RJR-202-MW22 JB3044 25-May-01				RJR-202-MW25 JB3047 15-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND				ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	ND				ND				ND				ND			
Benzene	mg/L	NA	1.41E-03	ND				ND				ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				ND				ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	ND				7.40E-02			YES	ND				ND			
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	ND				1.10E-03	B			ND				8.90E-04	J		
Chloromethane	mg/L	NA	3.93E-03	ND				ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				2.30E-03	B			2.20E-03	B			ND			
Tetrachloroethene	mg/L	NA	1.26E-03	ND				ND				ND				ND			
Toluene	mg/L	NA	2.59E-01	ND				ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	ND				ND				ND				ND			
p-Cymene	mg/L	NA	2.26E-01	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	NR				NR				NR				NR			
Phenol	mg/L	NA	9.31E-01	NR				NR				NR				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	NR				NR				NR				NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	ND				ND				ND				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	4.79E-01				2.33E-01				2.96E-01				3.33E-01			
Sulfate	mg/L	NA	NA	4.43E-01	J			1.04E+00				1.84E+00				3.29E+00			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 19 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW26 JB3048 11-May-01				RJR-202-MW27 JB3049 10-May-01				RJR-202-MW28 JB3050 10-May-01				RJR-202-MW30 JB3052 24-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	ND				ND				ND				ND			
Antimony	mg/L	3.19E-03	6.25E-04	ND				ND				2.97E-02	J	YES	YES	ND			
Arsenic	mg/L	1.78E-02	4.46E-05	ND				ND				ND				ND			
Barium	mg/L	1.27E-01	1.10E-01	6.09E-03	J			8.87E-02				1.04E-02				9.53E-03	J		
Calcium	mg/L	5.65E+01	NA	2.01E+01				1.79E+01				2.51E+01				2.53E+01			
Chromium	mg/L	NA	4.69E-03	ND				ND				ND				ND			
Copper	mg/L	2.55E-02	6.26E-02	ND				ND				ND				ND			
Iron	mg/L	7.04E+00	4.69E-01	ND				ND				ND				ND			
Magnesium	mg/L	2.13E+01	NA	1.17E+01				1.23E+01				1.38E+01				1.52E+01			
Manganese	mg/L	5.81E-01	7.35E-02	ND				3.25E-02				ND				2.23E-02			
Potassium	mg/L	7.20E+00	NA	ND				5.49E+01		YES		ND				ND			
Selenium	mg/L	NA	7.82E-03	ND				ND				ND				2.40E-03	B		
Silver	mg/L	4.00E-03	7.82E-03	ND				ND				ND				ND			
Sodium	mg/L	1.48E+01	NA	1.06E+00				1.43E+01				4.79E+00				1.68E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	ND				ND				ND				ND			
Zinc	mg/L	2.20E-01	4.69E-01	ND				ND				ND				ND			
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	9.09E-02	J			7.25E-02	J			1.62E-01	J			4.85E-02	J		
Antimony	mg/L	3.19E-03	6.25E-04	ND				ND				ND				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	ND				ND				ND				ND			
Barium	mg/L	1.27E-01	1.10E-01	6.57E-03	J			7.30E-02				1.34E-02				9.53E-03	J		
Beryllium	mg/L	1.25E-03	3.13E-03	ND				ND				ND				ND			
Calcium	mg/L	5.65E+01	NA	1.95E+01				1.46E+01				2.41E+01				2.43E+01			
Chromium	mg/L	NA	4.69E-03	ND				ND				ND				ND			
Copper	mg/L	2.55E-02	6.26E-02	ND				ND				ND				ND			
Iron	mg/L	7.04E+00	4.69E-01	2.13E-01				6.72E-02	J			1.92E-01	J			2.61E-01	J		
Lead	mg/L	8.00E-03	1.50E-02	ND				ND				ND				ND			
Magnesium	mg/L	2.13E+01	NA	1.14E+01				1.01E+01				1.34E+01				1.44E+01			
Manganese	mg/L	5.81E-01	7.35E-02	7.83E-03	J			5.23E-02				1.40E-02				2.58E-02			
Nickel	mg/L	NA	3.13E-02	ND				ND				ND				ND			
Potassium	mg/L	7.20E+00	NA	ND				4.50E+01		YES		ND				ND			
Selenium	mg/L	NA	7.82E-03	ND				ND				ND				2.13E-03	B		
Silver	mg/L	4.00E-03	7.82E-03	ND				ND				ND				ND			
Sodium	mg/L	1.48E+01	NA	1.06E+00				1.18E+01				4.38E+00				1.68E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	ND				ND				ND				ND			
Zinc	mg/L	2.20E-01	4.69E-01	ND				ND				ND				ND			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 20 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW26 JB3048 11-May-01				RJR-202-MW27 JB3049 10-May-01				RJR-202-MW28 JB3050 10-May-01				RJR-202-MW30 JB3052 24-May-01			
Parameter	Units	BKG ^a	SSSL ^a	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND				ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	ND				1.20E-01				ND				ND			
Benzene	mg/L	NA	1.41E-03	ND				ND				ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				ND				ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	ND				ND				ND				ND			
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	ND				ND				1.10E-03	B			8.50E-04	B		
Chloromethane	mg/L	NA	3.93E-03	ND				ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				ND				ND				ND			
Tetrachloroethene	mg/L	NA	1.26E-03	ND				ND				ND				ND			
Toluene	mg/L	NA	2.59E-01	ND				ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	ND				ND				ND				ND			
p-Cymene	mg/L	NA	2.26E-01	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	NR				NR				NR				NR			
Phenol	mg/L	NA	9.31E-01	NR				NR				NR				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	NR				NR				NR				NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	ND				ND				ND				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	8.67E+02				8.68E+02				3.93E-01				3.89E-01			
Sulfate	mg/L	NA	NA	1.12E+00				6.07E+00				7.02E+00				1.63E+00			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 21 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW31 JB3054 14-May-01				RJR-202-MW32 JB3055 9-May-01				RJR-202-MW33 JB3056 23-May-01				RJR-202-MW34 JB3057 16-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED																			
Aluminum	mg/L	2.34E+00	1.56E+00	4.95E-02	J			ND				2.56E-01				1.01E+00			
Antimony	mg/L	3.19E-03	6.25E-04	3.16E-02	J	YES	YES	ND				ND				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	ND				ND				ND				2.49E-03	J		YES
Barium	mg/L	1.27E-01	1.10E-01	3.51E-02				1.28E-02				9.73E-02				7.50E-02			
Calcium	mg/L	5.65E+01	NA	2.51E+01				1.78E+01				5.02E+01				8.92E+00			
Chromium	mg/L	NA	4.69E-03	ND				ND				1.73E-02		YES		ND			
Copper	mg/L	2.55E-02	6.26E-02	ND				ND				ND				ND			
Iron	mg/L	7.04E+00	4.69E-01	ND				1.67E-02	J			ND				5.26E-01			YES
Magnesium	mg/L	2.13E+01	NA	1.21E+01				1.33E+01				ND				1.65E+00			
Manganese	mg/L	5.81E-01	7.35E-02	4.19E-02				ND				ND				1.29E-02			
Potassium	mg/L	7.20E+00	NA	5.84E+00				8.20E+00		YES		6.51E+01		YES		4.20E+00	J		
Selenium	mg/L	NA	7.82E-03	2.79E-03	J			ND				ND				ND			
Silver	mg/L	4.00E-03	7.82E-03	ND				ND				ND				ND			
Sodium	mg/L	1.48E+01	NA	7.40E+00				9.75E+00				4.52E+01		YES		4.93E+01		YES	
Vanadium	mg/L	1.70E-02	1.10E-02	ND				ND				ND				ND			
Zinc	mg/L	2.20E-01	4.69E-01	ND				ND				ND				9.55E-03	J		
METALS, TOTAL																			
Aluminum	mg/L	2.34E+00	1.56E+00	6.23E-01				7.83E-02	J			6.40E-01				9.40E-02	B		
Antimony	mg/L	3.19E-03	6.25E-04	4.19E-02	B	YES	YES	ND				ND				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	2.59E-03	J		YES	ND				ND				ND			
Barium	mg/L	1.27E-01	1.10E-01	3.73E-02				1.31E-02				1.17E-01		YES		5.71E-02			
Beryllium	mg/L	1.25E-03	3.13E-03	ND				ND				ND				ND			
Calcium	mg/L	5.65E+01	NA	2.52E+01				1.56E+01				6.33E+01		YES		5.49E+00			
Chromium	mg/L	NA	4.69E-03	ND				ND				1.54E-02		YES		ND			
Copper	mg/L	2.55E-02	6.26E-02	ND				ND				ND				ND			
Iron	mg/L	7.04E+00	4.69E-01	6.69E-01			YES	5.65E-02	J			7.89E-02	J			ND			
Lead	mg/L	8.00E-03	1.50E-02	ND				ND				ND				ND			
Magnesium	mg/L	2.13E+01	NA	1.23E+01				1.18E+01				1.96E+00				3.18E-01	J		
Manganese	mg/L	5.81E-01	7.35E-02	6.73E-02				8.21E-03	J			4.26E-03	J			ND			
Nickel	mg/L	NA	3.13E-02	ND				ND				ND				ND			
Potassium	mg/L	7.20E+00	NA	6.01E+00				7.51E+00		YES		7.11E+01		YES		4.06E+00	J		
Selenium	mg/L	NA	7.82E-03	2.29E-03	J			ND				1.67E-03	J			ND			
Silver	mg/L	4.00E-03	7.82E-03	ND				ND				ND				ND			
Sodium	mg/L	1.48E+01	NA	7.36E+00				8.97E+00				5.02E+01		YES		4.76E+01		YES	
Vanadium	mg/L	1.70E-02	1.10E-02	ND				ND				ND				4.12E-03	B		
Zinc	mg/L	2.20E-01	4.69E-01	8.48E-03	J			ND				ND				ND			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 22 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW31 JB3054 14-May-01				RJR-202-MW32 JB3055 9-May-01				RJR-202-MW33 JB3056 23-May-01				RJR-202-MW34 JB3057 16-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS																			
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND				ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND				ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND				ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND				ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND				ND				ND			
Acetone	mg/L	NA	1.56E-01	ND				ND				2.00E-02				ND			
Benzene	mg/L	NA	1.41E-03	ND				ND				ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND				ND				ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND				ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	ND				ND				ND				ND			
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND				ND				ND			
Chloroform	mg/L	NA	1.15E-03	ND				7.50E-04	B			ND				2.70E-03	J		YES
Chloromethane	mg/L	NA	3.93E-03	ND				ND				ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND				ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				ND				ND				ND			
Tetrachloroethene	mg/L	NA	1.26E-03	ND				ND				ND				ND			
Toluene	mg/L	NA	2.59E-01	ND				ND				ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	ND				ND				ND				1.80E-02			YES
p-Cymene	mg/L	NA	2.26E-01	ND				ND				ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS																			
2-Nitrophenol	mg/L	NA	1.23E-02	NR				NR				NR				NR			
Phenol	mg/L	NA	9.31E-01	NR				NR				NR				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	NR				NR				NR				NR			
TOTAL ORGANIC CARBON																			
Total Organic Carbon	mg/L	NA	NA	ND				ND				5.00E+00				ND			
WET CHEMISTRY																			
Nitrite, Nitrate	mg/L	NA	NA	6.31E-01				8.57E+02				2.65E-01				4.17E-01			
Sulfate	mg/L	NA	NA	9.30E+00				2.27E+00				1.01E+01				2.84E+01			

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 23 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW35 JB3058 21-May-01				RJR-202-MW36 JB3060 22-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
METALS, DISSOLVED											
Aluminum	mg/L	2.34E+00	1.56E+00	4.98E-02	J			ND			
Antimony	mg/L	3.19E-03	6.25E-04	ND				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	ND				ND			
Barium	mg/L	1.27E-01	1.10E-01	6.13E-02				4.79E-03	J		
Calcium	mg/L	5.65E+01	NA	1.34E+01				2.57E+01			
Chromium	mg/L	NA	4.69E-03	6.83E-03	J		YES	ND			
Copper	mg/L	2.55E-02	6.26E-02	ND				ND			
Iron	mg/L	7.04E+00	4.69E-01	ND				2.98E-02	B		
Magnesium	mg/L	2.13E+01	NA	7.73E+00				1.57E+01			
Manganese	mg/L	5.81E-01	7.35E-02	ND				1.76E-03	J		
Potassium	mg/L	7.20E+00	NA	1.43E+02		YES		ND			
Selenium	mg/L	NA	7.82E-03	ND				ND			
Silver	mg/L	4.00E-03	7.82E-03	ND				ND			
Sodium	mg/L	1.48E+01	NA	5.44E+01		YES		2.31E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	1.01E-02				ND			
Zinc	mg/L	2.20E-01	4.69E-01	ND				ND			
METALS, TOTAL											
Aluminum	mg/L	2.34E+00	1.56E+00	1.24E-01	J			7.99E-01			
Antimony	mg/L	3.19E-03	6.25E-04	ND				ND			
Arsenic	mg/L	1.78E-02	4.46E-05	ND				ND			
Barium	mg/L	1.27E-01	1.10E-01	7.13E-02				8.32E-03	J		
Beryllium	mg/L	1.25E-03	3.13E-03	ND				ND			
Calcium	mg/L	5.65E+01	NA	1.45E+01				2.75E+01			
Chromium	mg/L	NA	4.69E-03	6.07E-03	J		YES	ND			
Copper	mg/L	2.55E-02	6.26E-02	ND				ND			
Iron	mg/L	7.04E+00	4.69E-01	7.88E-02	J			8.48E-01			YES
Lead	mg/L	8.00E-03	1.50E-02	ND				1.55E-03	B		
Magnesium	mg/L	2.13E+01	NA	8.58E+00				1.69E+01			
Manganese	mg/L	5.81E-01	7.35E-02	6.59E-03	J			3.45E-02			
Nickel	mg/L	NA	3.13E-02	ND				ND			
Potassium	mg/L	7.20E+00	NA	1.50E+02		YES		ND			
Selenium	mg/L	NA	7.82E-03	ND				ND			
Silver	mg/L	4.00E-03	7.82E-03	ND				ND			
Sodium	mg/L	1.48E+01	NA	5.76E+01		YES		2.31E+00			
Vanadium	mg/L	1.70E-02	1.10E-02	9.20E-03	J			ND			
Zinc	mg/L	2.20E-01	4.69E-01	ND				1.60E-02	J		

Table 4-3

Groundwater Analytical Results
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 24 of 24)

Sample Location Sample Number Sample Date				RJR-202-MW35 JB3058 21-May-01				RJR-202-MW36 JB3060 22-May-01			
Parameter	Units	BKG ^a	SSSL ^b	Result	Qual	>BKG	>SSSL	Result	Qual	>BKG	>SSSL
VOLATILE ORGANIC COMPOUNDS											
1,1,2,2-Tetrachloroethane	mg/L	NA	2.03E-04	ND				ND			
1,2,4-Trichlorobenzene	mg/L	NA	1.35E-02	ND				ND			
1,2-Dichloroethane	mg/L	NA	4.48E-04	ND				ND			
1,4-Dichlorobenzene	mg/L	NA	1.76E-03	ND				ND			
2-Butanone	mg/L	NA	7.14E-01	ND				ND			
Acetone	mg/L	NA	1.56E-01	1.80E-02	J			ND			
Benzene	mg/L	NA	1.41E-03	ND				ND			
Bromomethane	mg/L	NA	2.18E-03	ND				ND			
Carbon disulfide	mg/L	NA	1.51E-01	ND				ND			
Carbon tetrachloride	mg/L	NA	4.08E-04	1.80E-03	J		YES	ND			
Chlorobenzene	mg/L	NA	1.62E-02	ND				ND			
Chloroform	mg/L	NA	1.15E-03	7.40E-04	B			ND			
Chloromethane	mg/L	NA	3.93E-03	ND				ND			
Hexachlorobutadiene	mg/L	NA	8.39E-04	ND				ND			
Methylene chloride	mg/L	NA	7.85E-03	ND				ND			
Tetrachloroethene	mg/L	NA	1.26E-03	ND				ND			
Toluene	mg/L	NA	2.59E-01	ND				ND			
Trichloroethene	mg/L	NA	4.51E-03	2.10E-03	J			2.10E-03	J		
p-Cymene	mg/L	NA	2.26E-01	ND				ND			
SEMIVOLATILE ORGANIC COMPOUNDS											
2-Nitrophenol	mg/L	NA	1.23E-02	NR				NR			
Phenol	mg/L	NA	9.31E-01	NR				NR			
bis(2-Ethylhexyl)phthalate	mg/L	NA	4.31E-03	NR				NR			
TOTAL ORGANIC CARBON											
Total Organic Carbon	mg/L	NA	NA	7.90E+00	J			ND			
WET CHEMISTRY											
Nitrite, Nitrate	mg/L	NA	NA	2.20E-01				2.29E-01			
Sulfate	mg/L	NA	NA	3.59E+00				1.82E+00			

Analyses performed using U.S. Environmental Protection Agency (EPA) SW-846 analytical methods.

^b BKG - Background. Concentration listed is two times (2x) the arithmetic mean of background metals concentration given in SAIC, 1998, *Final Background Metals Survey Report, Fort McClellan, Alabama*, July.

^c Residential human health site-specific screening level (SSSL) as given in IT Corporation (2000), *Final Human Health and Ecological Screening Values and PAH Background Summary Report, Fort McClellan, Calhoun County, Alabama*, July.

B - Analyte detected in laboratory or field blank at concentration greater than the reporting limit (and greater than zero).

J - Compound was positively identified; reported value is an estimated concentration.

mg/L - Milligrams per liter.

NA - Not available.

ND - Not detected.

NR - Not requested.

Qual - Data validation qualifier.

- Iron (38,200 mg/kg) exceeded its SSSL (2,345 mg/kg) and background (34,154 mg/kg) at sample location RJR-202-GP21.
- Vanadium (74.3 mg/kg) exceeded its SSSL (53.1 mg/kg) and background (58.8 mg/kg) at sample location RJR-202-GP21.

The concentrations of eight metals (aluminum, arsenic, chromium, iron, manganese, mercury, vanadium, and zinc) exceeded ESVs. Of these, arsenic, chromium, iron, mercury, vanadium, and zinc exceeded their respective background concentrations:

- Arsenic (13.9 to 24.3 mg/kg) exceeded its ESV (10 mg/kg) and background (13.7 mg/kg) at three sample locations.
- Chromium (37.1 and 51.7 mg/kg) exceeded its ESV (0.4 mg/kg) and background (37.0 mg/kg) at two sample locations. Both chromium results were “J” flagged, indicating that the concentrations were estimated.
- Iron (38,200 mg/kg) exceeded its ESV (200 mg/kg) and background (34,154 mg/kg) at sample location RJR-202-GP21.
- Mercury (0.11 mg/kg) exceeded its ESV (0.1 mg/kg) and background (0.08 mg/kg) at sample location RJR-202-GP17.
- Vanadium (74.3 mg/kg) exceeded its ESV (2 mg/kg) and background (58.8 mg/kg) at sample location RJR-202-GP21.
- Zinc (60.4 to 69.5 mg/kg) exceeded its ESV (50 mg/kg) and background (40.6 mg/kg) at three sample locations.

An integrated statistical and geochemical evaluation of metals concentrations in soils was performed for Range J and is included as Appendix K. The study concluded that the metals that exceeded ESVs and SSSLs in surface soils are naturally occurring.

VOCs. All surface soil samples collected during the supplemental RI at Range J were analyzed for VOCs. A total of 14 VOCs were detected in the samples. The majority of the bromomethane, chloromethane, methylene chloride, and trichlorofluoromethane results were flagged with a “B” data qualifier, signifying that these compounds were also detected in an associated laboratory or field blank sample. All but five of the remaining VOC results were flagged with a “J” data qualifier, indicating that the compounds were positively identified but the concentrations were estimated. VOC concentrations in surface soils ranged from 0.00079 to 21

mg/kg. The VOC concentrations in surface soils were below SSSLs. The concentration of acetone (21 mg/kg) exceeded its ESV (2.5 mg/kg) at one sample location (RJR-202-MW09).

SVOCs. Twenty-four surface soil samples collected during Phases I and II of the supplemental RI were analyzed for SVOCs. Di-n-butyl phthalate and bis(2-ethylhexyl)phthalate were the only SVOCs detected in the samples. The majority of the results were flagged with a “B” data qualifier, signifying that these compounds were also detected in an associated laboratory or field blank sample. The remaining results were flagged with a “J” data qualifier, signifying that these SVOCs were positively identified but the concentrations were estimated. SVOC concentrations in surface soils ranged from 0.047 mg/kg to 0.099 mg/kg and were all below SSSLs and ESVs.

CWM Breakdown Products. Samples collected during Phases I and II of the supplemental RI at Range J, Parcel 202, were analyzed for CWM breakdown products. During Phase I, it was necessary to resample and analyze for CWM breakdown products after approximately 9 months, due to analysis being performed outside of holding times. CWM breakdown products were not detected in surface soils at Range J, Parcel 202(7).

4.3.2 Subsurface Soil Analytical Results

Thirty-four subsurface soil samples were collected for chemical analysis at Range J, Parcel 202(7). At 16 soil sample locations, samples were re-collected and analyzed only for CWM breakdown products because holding times were exceeded during analysis of the original sample. Subsurface soil samples were collected from 32 soil borings at depths greater than 1 foot bgs at the locations shown on Figures 2-2 and 2-3. Analytical results were compared to residential human health SSSLs and metals background screening values, as presented in Table 4-2.

Metals. Eight subsurface soil samples collected during Phase III of the supplemental RI were analyzed for metals. A total of twenty metals were detected in the samples. The thallium results were flagged with a “B” data qualifier, signifying that this metal was also detected in an associated laboratory or field blank sample. The majority of the remaining metals results were flagged with a “J” data qualifier indicating that the results were estimated concentrations.

The concentrations of six metals (arsenic, chromium, iron, manganese, thallium, and vanadium) exceeded SSSLs. Of these metals, arsenic, iron, thallium, and vanadium also exceeded their respective background concentrations:

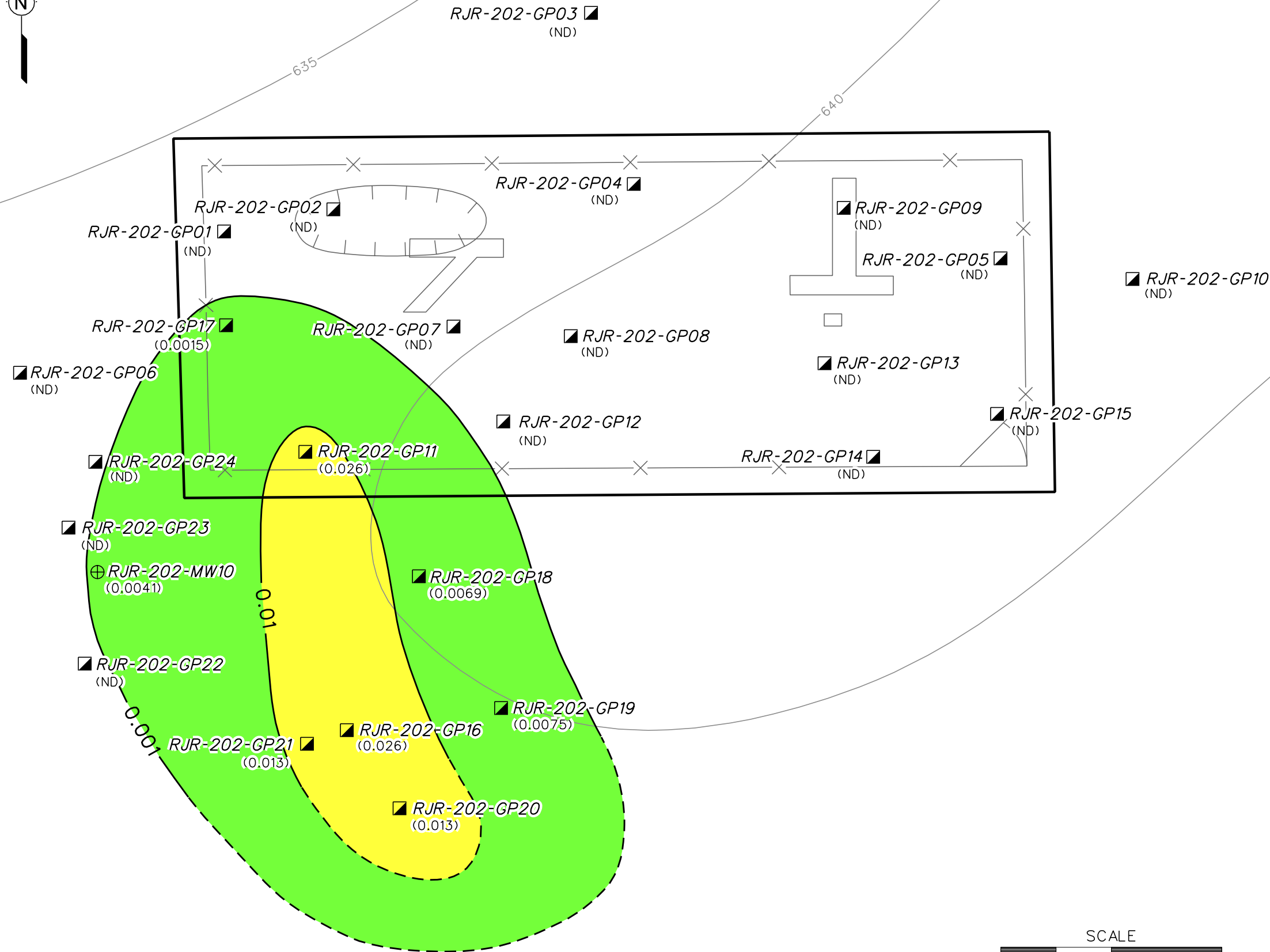
- Arsenic (21.7 to 63.2 mg/kg) exceeded its SSSL (0.4 mg/kg) and background (18.3 mg/kg) at seven sample locations.
- Iron (46,900 to 64,900 mg/kg) exceeded its SSSL (2,345 mg/kg) and background (44,817 mg/kg) at three sample locations.
- Thallium (1.5 mg/kg, “B” flagged) exceeded its SSSL (0.5 mg/kg) and background (1.4 mg/kg) at sample location RJR-202-GP18.
- Vanadium (76.7 to 87.9 mg/kg) exceeded its SSSL (53.1 mg/kg) and background (64.9 mg/kg) at three sample locations.

The subsurface soil metals data were evaluated using the integrated statistical and geochemical approach previously discussed (Appendix K). The evaluation concluded that the metals that exceeded SSSLs in subsurface soils are naturally occurring.

VOCs. All subsurface soil samples collected during the supplemental RI were analyzed for VOCs. A total of 11 VOCs were detected in the samples. The bromomethane results and a majority of the methylene chloride and trichlorofluoromethane results were flagged with a “B” data qualifier, signifying that these compounds were also detected in an associated laboratory or field blank sample. The VOC concentrations in subsurface soils ranged from 0.0012 to 2.2 mg/kg and were all below SSSLs.

The most significant VOC detected in subsurface soils at Range J was carbon tetrachloride, which was detected in eight samples at depths ranging from 8 to 21 feet bgs. Carbon tetrachloride concentrations in the samples ranged from 0.0015 to 0.026 mg/kg, all of which were well below the residential human health SSSL (4.83 mg/kg). The samples with the carbon tetrachloride detections were collected both inside and outside of the west-southwest part of the fenced area. The distribution of carbon tetrachloride in subsurface soil is shown on Figure 4-2.

SVOCs. Twenty-six subsurface soil samples collected during Phases I and II of the supplemental RI were analyzed for SVOCs. A total of four SVOCs, including two Polynuclear aromatic hydrocarbon (PAH) compounds, were detected in the samples. The di-n-butyl phthalate result and all but one of the bis(2-ethylhexyl)phthalate results were flagged with a “B” data qualifier, signifying that these SVOCs were also detected in an associated laboratory or field blank sample. Phthalates are common sample contaminants. The two PAH compounds, benzo(a)anthracene and chrysene, were detected at only one sample location (RJR-202-MW10, 19 to 21 feet bgs) and the results were flagged with a “J” data qualifier, signifying that these



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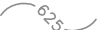





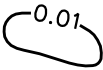
	TOPOGRAPHIC CONTOURS
	PARCEL BOUNDARY
	FENCE
	FORMER SOIL / DRUM DISPOSAL PIT
	FORMER TRENCH EXCAVATION
	SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION
	CARBON TETRACHLORIDE CONCENTRATION (mg/kg) (DASHED WHERE INFERRED)
(0.0015)	CONCENTRATION IN MILLIGRAMS PER KILOGRAM (mg/kg)
(ND)	NOT DETECTED

FIGURE 4-2
ISOCONCENTRATION MAP
CARBON TETRACHLORIDE IN
SUBSURFACE SOIL
RANGE J - PELHAM RANGE
PARCEL 202(7)

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compounds were positively identified but the concentrations were estimated. The SVOC concentrations in subsurface soils ranged from 0.05 to 0.094 mg/kg and were all below SSSLs.

CWM Breakdown Products. Samples collected during Phases I and II of the supplemental RI at Range J, Parcel 202, were analyzed for CWM breakdown products. During Phase I, it was necessary to resample and analyze for CWM breakdown products after approximately 9 months, due to analysis being performed outside of holding times. CWM breakdown products were not detected in subsurface soils at Range J, Parcel 202(7).

4.3.3 Groundwater Analytical Results

A total of 46 groundwater samples were collected from 30 monitoring wells at Range J at the locations shown on Figure 2-3. Analytical results were compared to residential human health SSSLs and metals background screening values, as presented in Table 4-3.

Dissolved Metals. Thirty groundwater samples collected during Phase II of the supplemental RI were analyzed for dissolved metals. Analysis for dissolved metals was performed to provide data on the degree of metals adsorption to particulates in groundwater. A total of 16 metals were detected in the samples. The concentrations of five metals (antimony, arsenic, chromium, manganese, and iron) exceeded SSSLs. With the exception of antimony in two samples, the concentrations of these metals were below their respective background concentrations (note: a background value for chromium was not available). Antimony concentrations (0.029 and 0.032 milligrams per liter [mg/L]) exceeded its SSSL (0.00063 mg/L) and background (0.0032 mg/L) in two samples (RJR-202-MW28 and RJR-2-2-MW31). The antimony results were flagged with a “J” data qualifier, indicating that the metal was positively identified but the concentrations were estimated.

Total Metals. Thirty groundwater samples collected during Phase II of the supplemental RI were analyzed for total metals. A total of 19 metals were detected in the samples. The concentrations of eight metals (aluminum, antimony, arsenic, barium, chromium, iron, manganese, and silver) exceeded SSSLs. With the exception of aluminum, antimony, and silver in one sample each, the concentrations of these metals were below their respective background concentrations (note: a background value for chromium was not available):

- Aluminum (2.82 mg/L) exceeded its SSSL (1.56 mg/L) and background (2.34 mg/L) in the sample collected from RJR-202-MW25.

- Antimony (0.042 mg/L) exceeded its SSSL (0.00063 mg/L) and background (0.0032 mg/L) in the sample collected from RJR-202-MW31.
- Silver (0.0089 mg/L) exceeded its SSSL (0.0078 mg/L) and background (0.004 mg/L) in the sample collected from RJR-202-MW06.

The antimony and silver results were both flagged with a “B” data qualifier, indicating that these metals were also detected in an associated laboratory or field blank sample.

The groundwater metals data (total metals) were evaluated using the integrated statistical and geochemical approach previously discussed (Appendix K). The evaluation concluded that the total metals that exceeded SSSLs in groundwater are naturally occurring.

VOCs. All groundwater samples collected during the supplemental RI were analyzed for VOCs. A total of 19 VOCs were detected in groundwater at Range J. The majority of the acetone, chloroform, and methylene chloride results were flagged with a “B” data qualifier, signifying that these VOCs were also detected in associated laboratory or field blank samples. VOC concentrations in groundwater ranged from 0.00011 to 11 mg/L. The concentrations of seven VOCs exceeded their respective SSSLs:

- 1,1,2,2-PCA (0.001 mg/L) in one well (RJR-202-MW03)
- 1,2-Dichloroethane (DCA) (0.032 mg/L) in one well (RJR-202-MW11)
- Benzene (2.2 and 3.5 mg/L) in one well (RJR-202-MW11)
- Carbon tetrachloride (0.00097 to 11 mg/L) in fourteen wells
- Chloroform (0.0013 to 0.13 mg/L) in five wells
- PCE (0.0024 to 0.017 mg/L) in three wells
- TCE (0.018 mg/L) in one well (RJR-202-MW34).

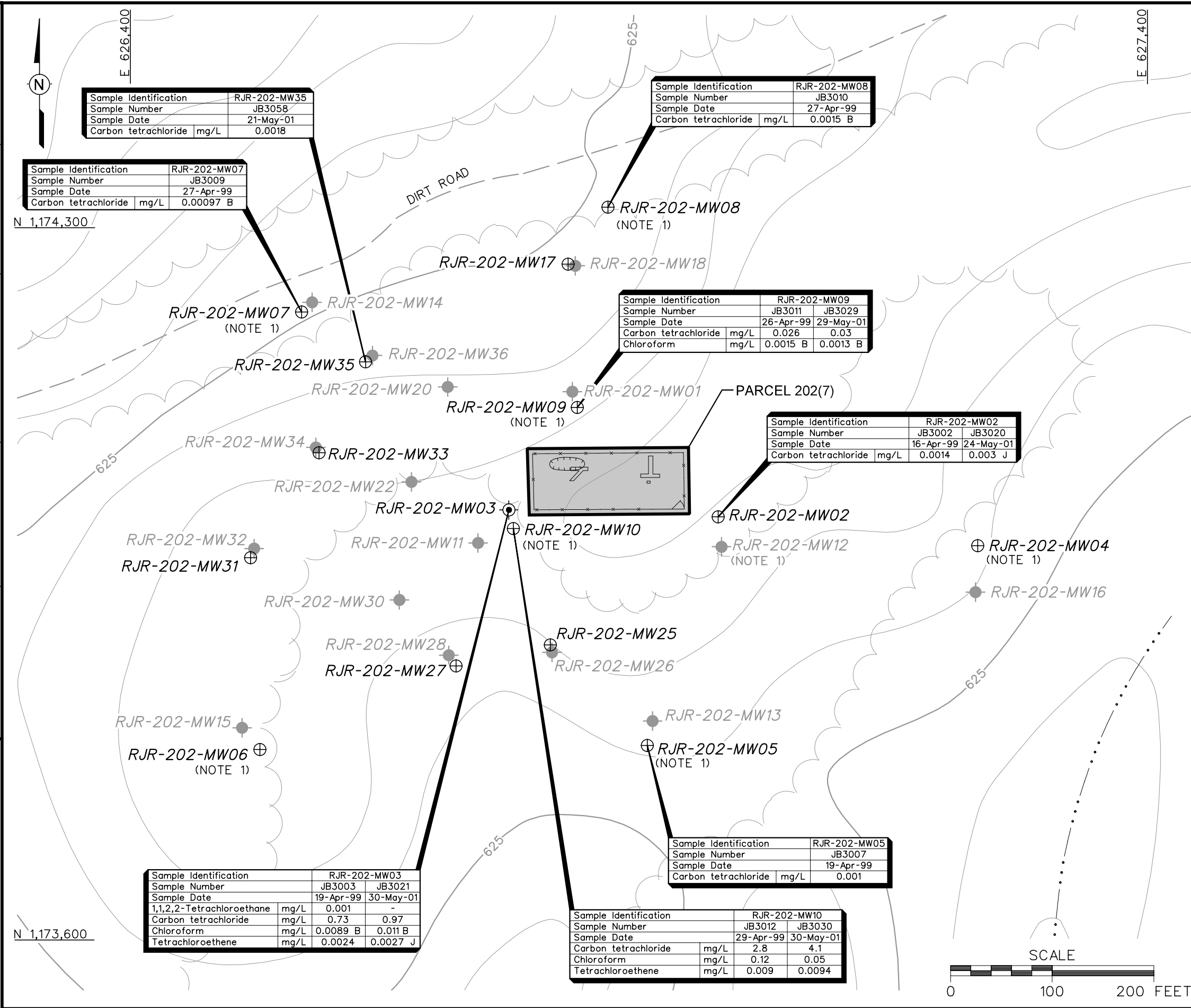
Figures 4-3 and 4-4 present the VOC results exceeding SSSLs in groundwater for the residuum and bedrock monitoring wells, respectively.

As concluded in Section 3.8.2.2, low groundwater flow velocity exists in both residuum and bedrock aquifers at the site. In view of the nature of the contaminants (predominantly chlorinated solvents) and the high degree of vertical connectivity at the site, a significant vertical distribution of contaminants is considered likely. In order to examine this distribution, monitoring wells were divided into three vertical zones: Zone A, Zone B, and Zone C, based on the elevations of well screen in the monitoring wells. Of the 31 wells, 16 were placed in the upper Zone A, 6 in the intermediate Zone B, and 9 in the lower Zone C. Essentially, Zone A wells correspond to wells screened in residuum, Zone B wells correspond to wells screened in

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PROJ. MGR.: J. YACOB
ENGR. CHK. BY: S. MORAN
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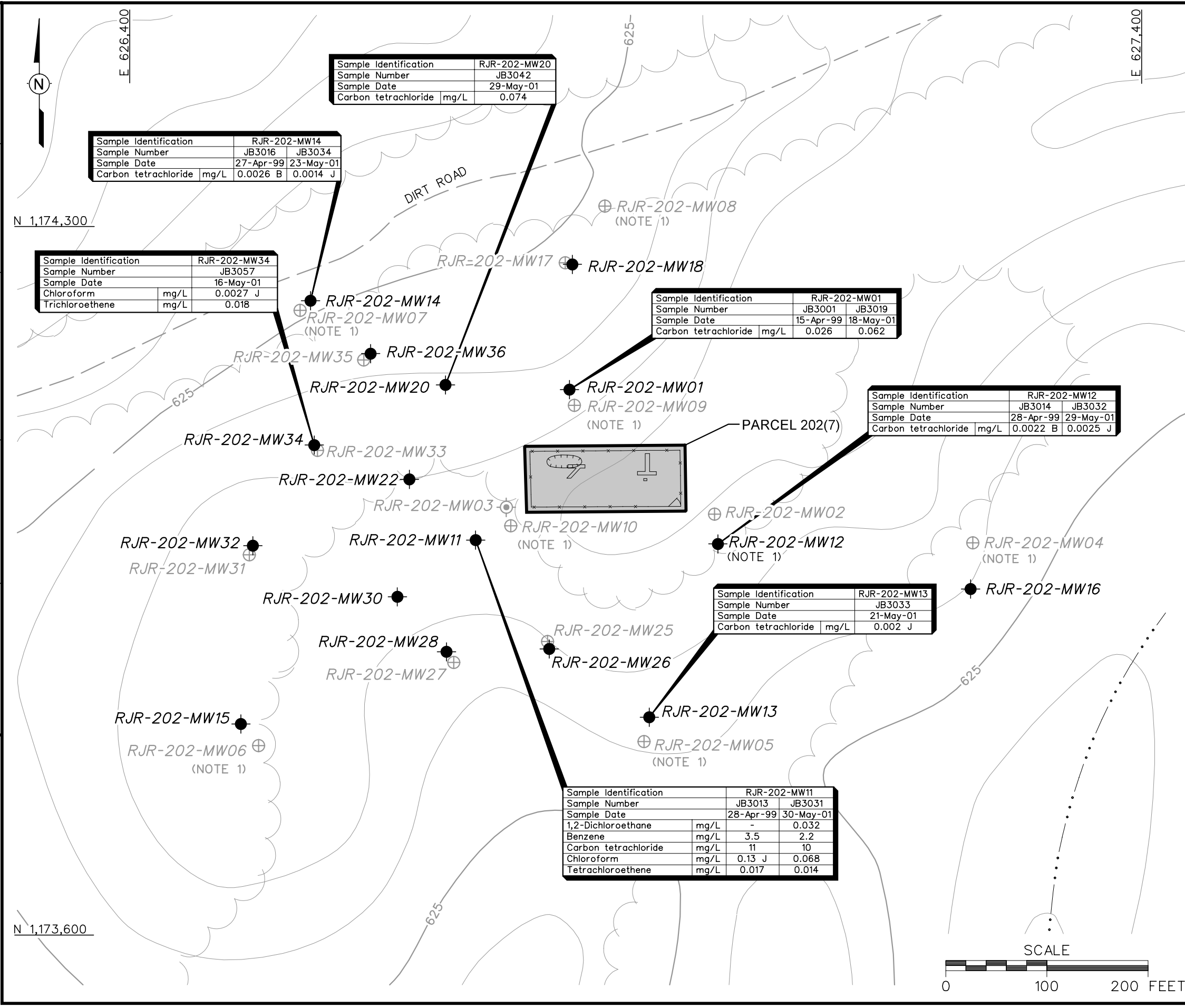
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PROJ. MGR.: J. YACOB

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- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION
 - J: COMPOUND WAS POSITIVELY IDENTIFIED; REPORTED VALUE IS AN ESTIMATED CONCENTRATION
 - B: ANALYTE DETECTED IN LABORATORY OR FIELD BLANK AT CONCENTRATION GREATER THAN THE REPORTING LIMIT
 - : NOT DETECTED
 - SSSL: SITE-SPECIFIC SCREENING LEVEL
 - mg/L: MILLIGRAMS PER LITER

NOTE:

1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.

FIGURE 4-4
VOCs EXCEEDING SSSLs
IN BEDROCK GROUNDWATER
RANGE J - PELHAM RANGE
PARCEL 202(7)

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the transitional interval, and Zone C wells correspond to wells screened in bedrock. Figure 4-5 shows the zone divisions based on screen intervals.

Isoconcentration maps (by zone) of total VOCs, chlorinated VOCs, and carbon tetrachloride are presented on Figures 4-6 through 4-8, Figures 4-9 through 4-11, and Figures 4-12 through 4-14, respectively. The isoconcentration maps of total VOCs and chlorinated VOCs reflect the same overall pattern of horizontal distribution for each of the three zones. Contamination in Zone A is centered at RJR-202-MW10. In Zone B, the maximum contamination migrates westward to center around monitoring well RJR-202-MW11; additional lateral spreading occurs towards the south and east. The extent of Zone C contamination is greatly reduced and reflects a west-northwest progression with depth to center at RJR-202-MW34. The extent of carbon tetrachloride contamination mirrors that of total VOCs and chlorinated VOCs for Zones A and B, but in the deep Zone C, it is restricted to a one-well occurrence at RJR-202-MW14.

SVOCs. Sixteen groundwater samples collected during Phase I of the supplemental RI were analyzed for SVOCs. A total of three SVOCs (2-nitrophenol, bis[2-ethylhexyl]phthalate, and phenol) were detected in the samples. The bis(2-ethylhexyl)phthalate results were flagged with a “B” data qualifier, signifying that this SVOC was also detected in an associated laboratory or field blank sample. Phenol and 2-nitrophenol were each detected in only one well (RJR-202-MW11), and the results were flagged with a “J” data qualifier, signifying that these SVOCs were positively identified but the concentrations were estimated. The concentration of bis(2-ethylhexyl)phthalate (0.0094 mg/L) exceeded its SSSL (0.0043 mg/L) in one sample (RJR-202-MW15). Bis(2-ethylhexyl)phthalate is a common sample contaminant.

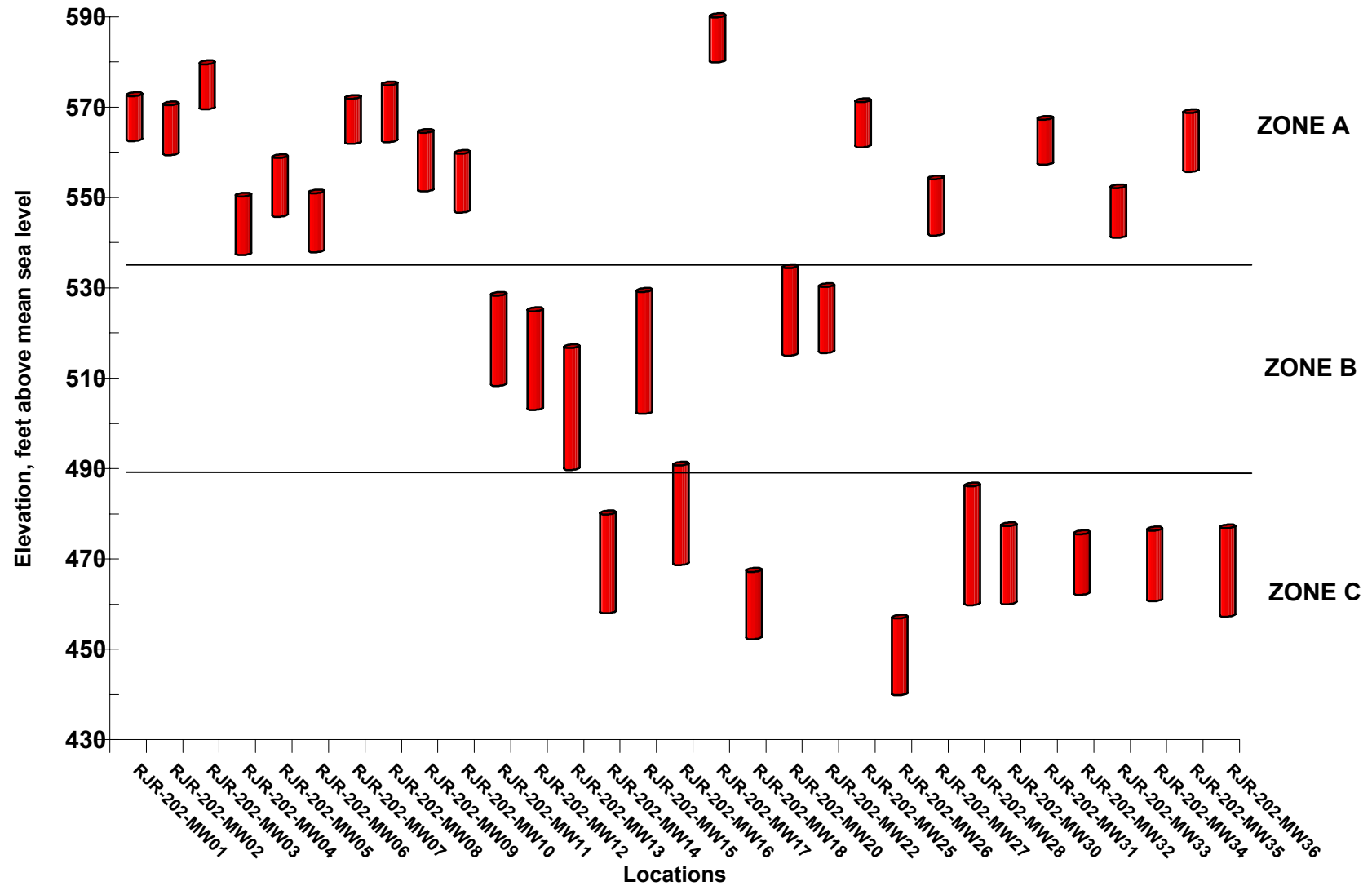
CWM Breakdown Products. Groundwater samples collected during Phase II of the Supplemental RI at Range J, Parcel 202, were analyzed for CWM breakdown products. CWM breakdown products were not detected in groundwater at Range J.

TOC. Thirty groundwater samples collected during Phase II of the supplemental RI were analyzed for total organic carbon (TOC). TOC was detected in two groundwater samples (RJR-202-MW33 and RJR-202-MW35) at concentrations of 5 mg/L and 7.9 mg/L, respectively.

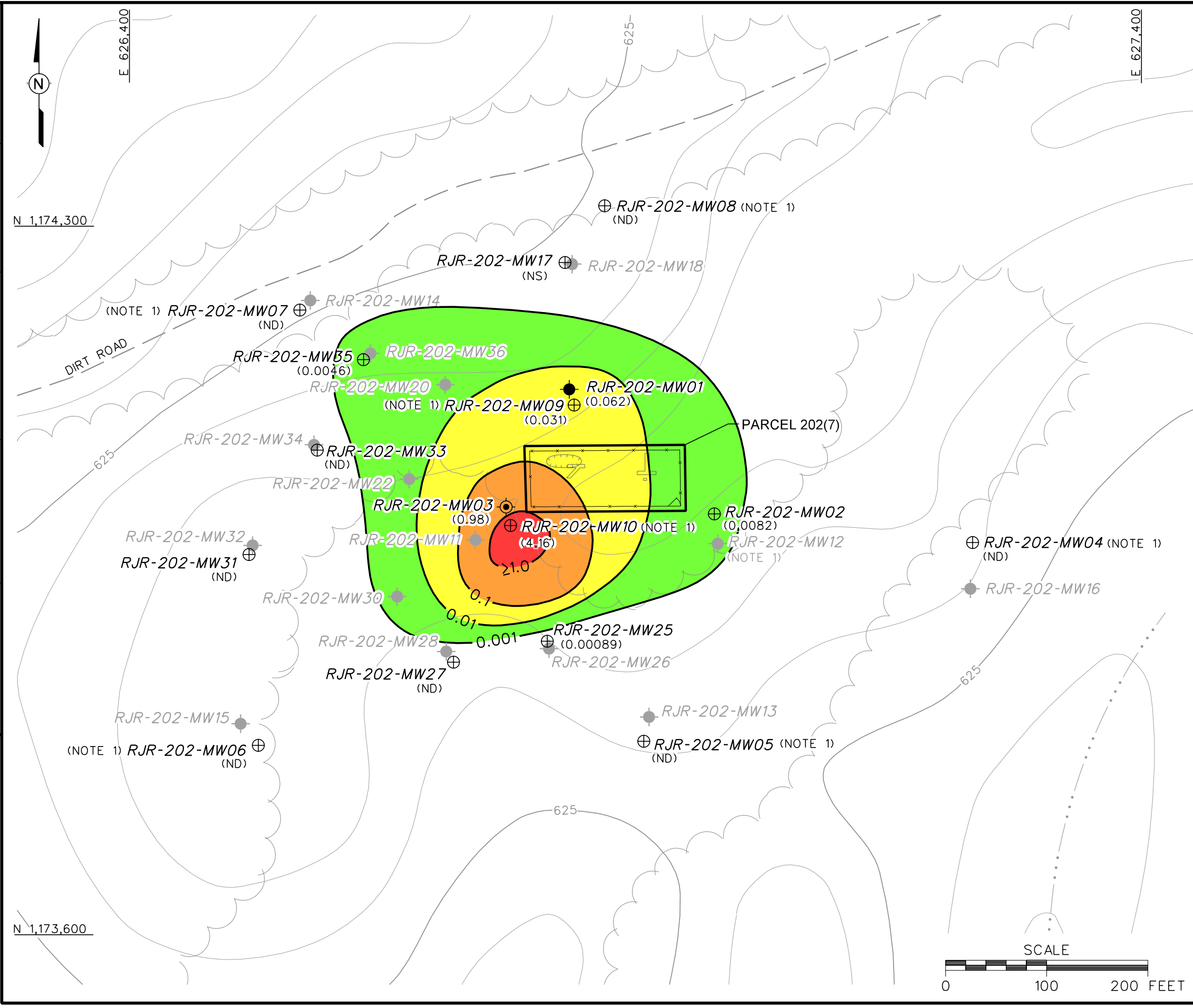
Nitrate/Nitrite. Thirty groundwater samples collected during Phase II of the supplemental RI were analyzed for nitrate/nitrite, which was detected in all of the samples at concentrations ranging from 0.034 mg/L (in RJR-202-MW14) to 868 mg/L (in RJR-202-MW27).

Figure 4-5

Zone Divisions Based on Screened Intervals
Range J - Pelham Range, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama



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INITIATOR: D. ALLAN
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- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION
 - TOTAL VOCs CONCENTRATION (mg/L) (DASHED WHERE INFERRED)
 - (0.062) CONCENTRATION IN MILLIGRAMS PER LITER (mg/L)
 - (ND) NOT DETECTED
 - (NS) NOT SAMPLED

- NOTES:**
1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.
 2. SHADED WELL LOCATIONS NOT INCLUDED IN ZONE A.
 3. TOTAL VOCs CALCULATED EXCLUDING COMMON LABORATORY CONTAMINANTS ACETONE AND METHYLENE CHLORIDE.

FIGURE 4-6
ISOCONCENTRATION MAP
TOTAL VOCs IN GROUNDWATER
(ZONE A)
RANGE J - PELHAM RANGE
PARCEL 202(7)

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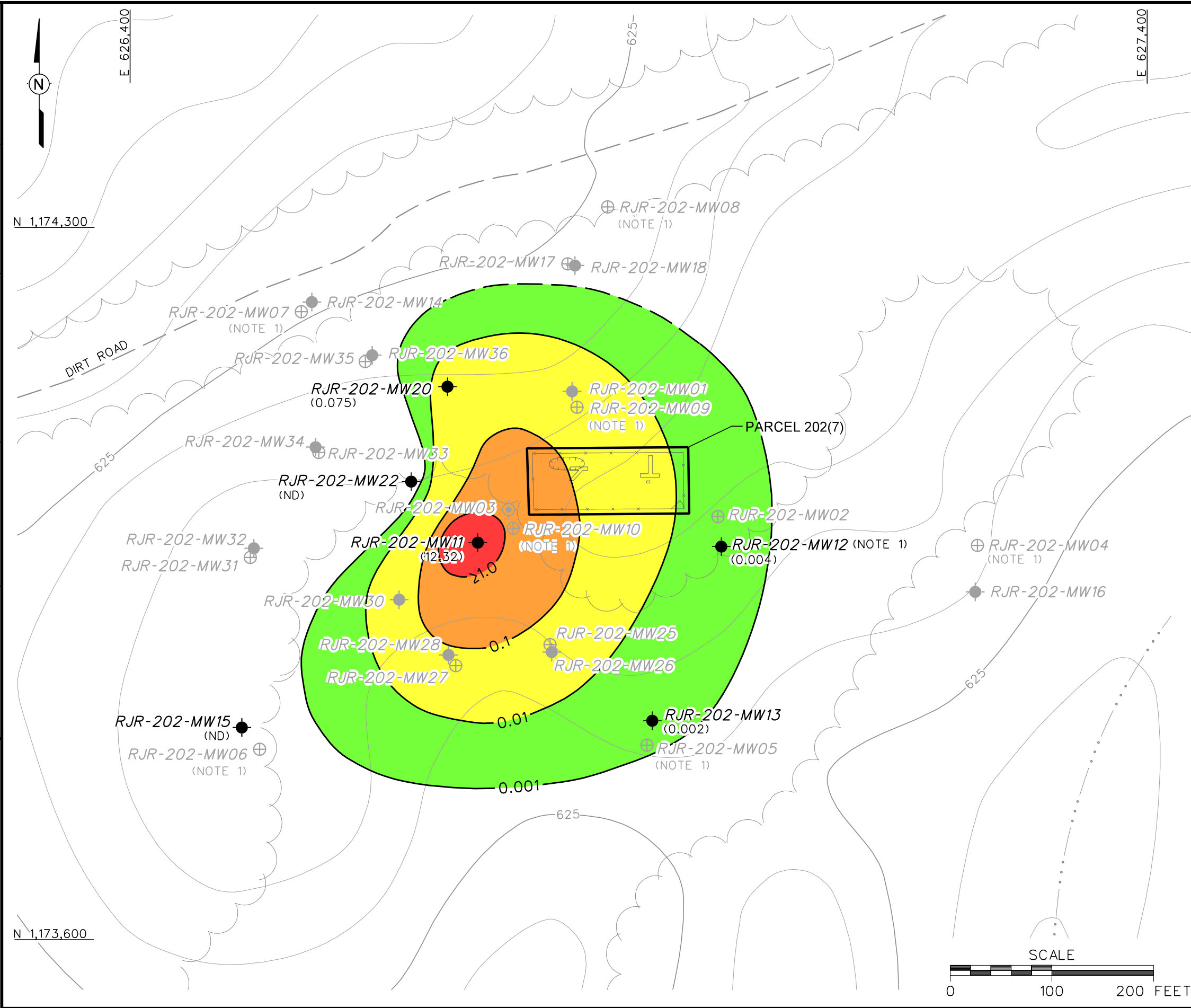
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PROJ. MGR.: J. YACOB

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LEGEND

TOPOGRAPHIC CONTOURS
(CONTOUR INTERVAL - 5 FOOT)

TREES / TREELINE

PARCEL BOUNDARY

FENCE

FORMER SOIL / DRUM DISPOSAL PIT

FORMER TRENCH EXCAVATION

RESIDUUM / BEDROCK MONITORING
WELL LOCATION

RESIDUUM MONITORING WELL LOCATION

BEDROCK MONITORING WELL LOCATION

TOTAL VOCs CONCENTRATION
(mg/L) (DASHED WHERE INFERRED)

(0.004) CONCENTRATION IN MILLIGRAMS PER
LITER (mg/L)

(ND) NOT DETECTED

- NOTES:**
1. SURFACE AND SUBSURFACE SOIL SAMPLES
ALSO COLLECTED AT THIS LOCATION.

2. SHADED WELL LOCATIONS NOT INCLUDED
IN ZONE B.

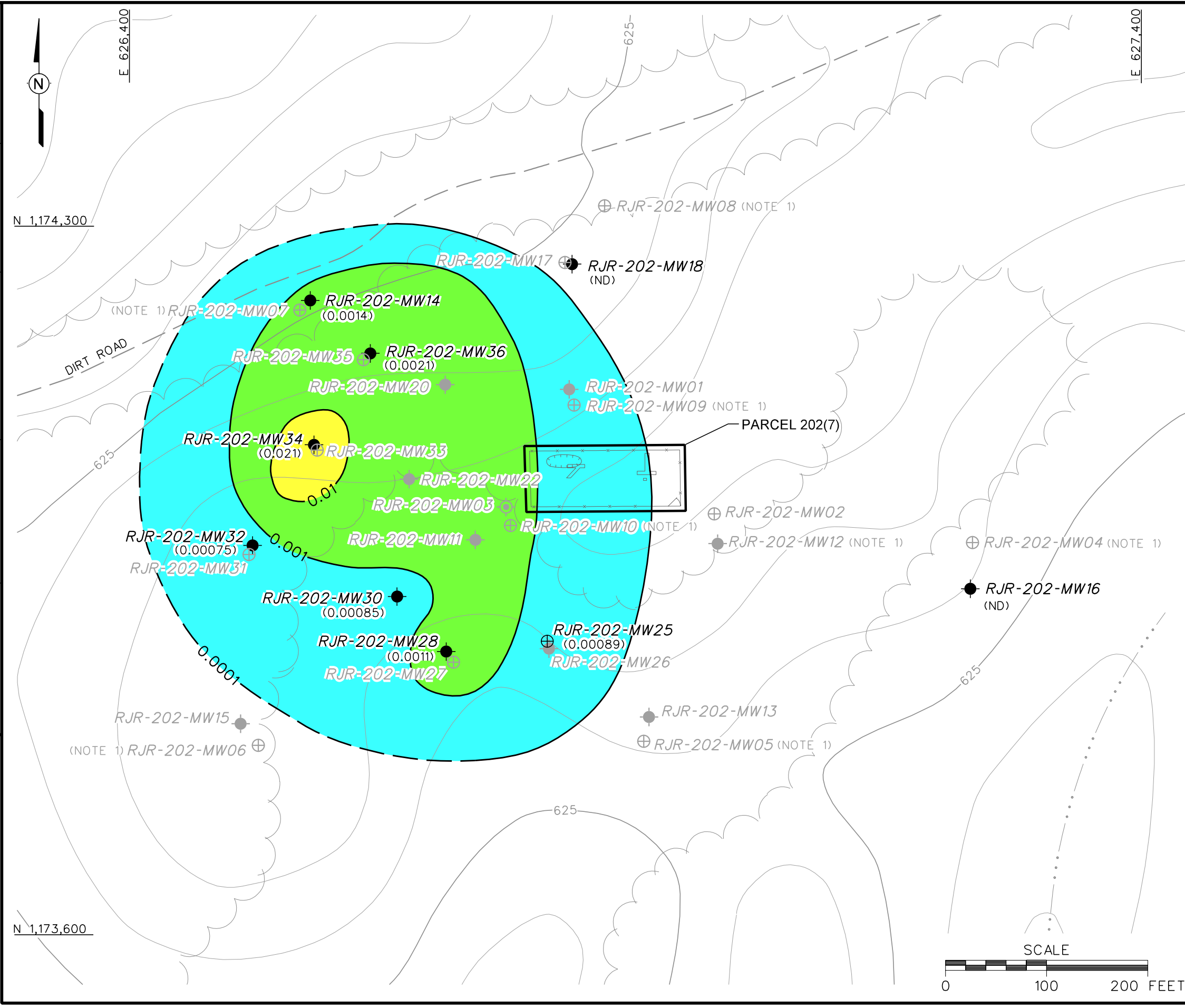
3. TOTAL VOCs CALCULATED EXCLUDING
COMMON LABORATORY CONTAMINANTS
ACETONE AND METHYLENE CHLORIDE.

FIGURE 4-7
ISOCONCENTRATION MAP
TOTAL VOCs IN GROUNDWATER
(ZONE B)
RANGE J - PELHAM RANGE
PARCEL 202(7)

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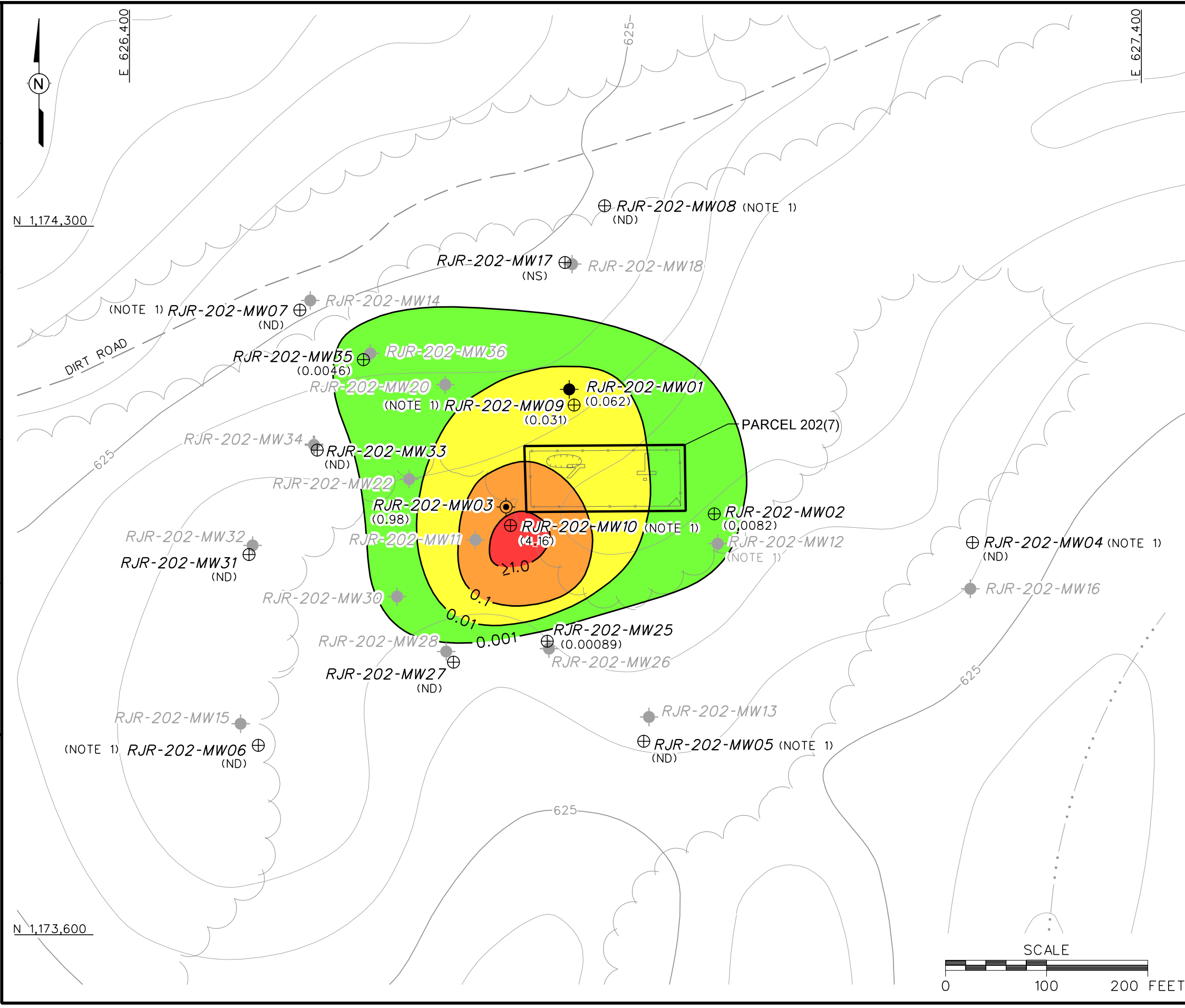
- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION
 - TOTAL VOCs CONCENTRATION (mg/L) (DASHED WHERE INFERRED)
 - (0.0021) CONCENTRATION IN MILLIGRAMS PER LITER (mg/L)
 - (ND) NOT DETECTED

- NOTES:**
1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.
 2. SHADED WELL LOCATIONS NOT INCLUDED IN ZONE C.
 3. TOTAL VOCs CALCULATED EXCLUDING COMMON LABORATORY CONTAMINANTS ACETONE AND METHYLENE CHLORIDE.

FIGURE 4-8
ISOCONCENTRATION MAP
TOTAL VOCs IN GROUNDWATER
(ZONE C)
RANGE J - PELHAM RANGE
PARCEL 202(7)

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FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

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ENGR, CHECK, BY: S. MORAN
INITIATOR: D. ALLAN
PROJ. MGR.: J. YACOB
PROJ. NO.: 774645
DWG. NO.: \774645es.883



LEGEND

- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
- TREES / TREELINE
- PARCEL BOUNDARY
- FENCE
- FORMER SOIL / DRUM DISPOSAL PIT
- FORMER TRENCH EXCAVATION
- RESIDUUM/BEDROCK MONITORING WELL LOCATION
- RESIDUUM MONITORING WELL LOCATION
- BEDROCK MONITORING WELL LOCATION
- CHLORINATED VOCs CONCENTRATION (mg/L) (DASHED WHERE INFERRED)
- (0.0046) CONCENTRATION IN MILLIGRAMS PER LITER (mg/L)
- (ND) NOT DETECTED
- (NS) NOT SAMPLED

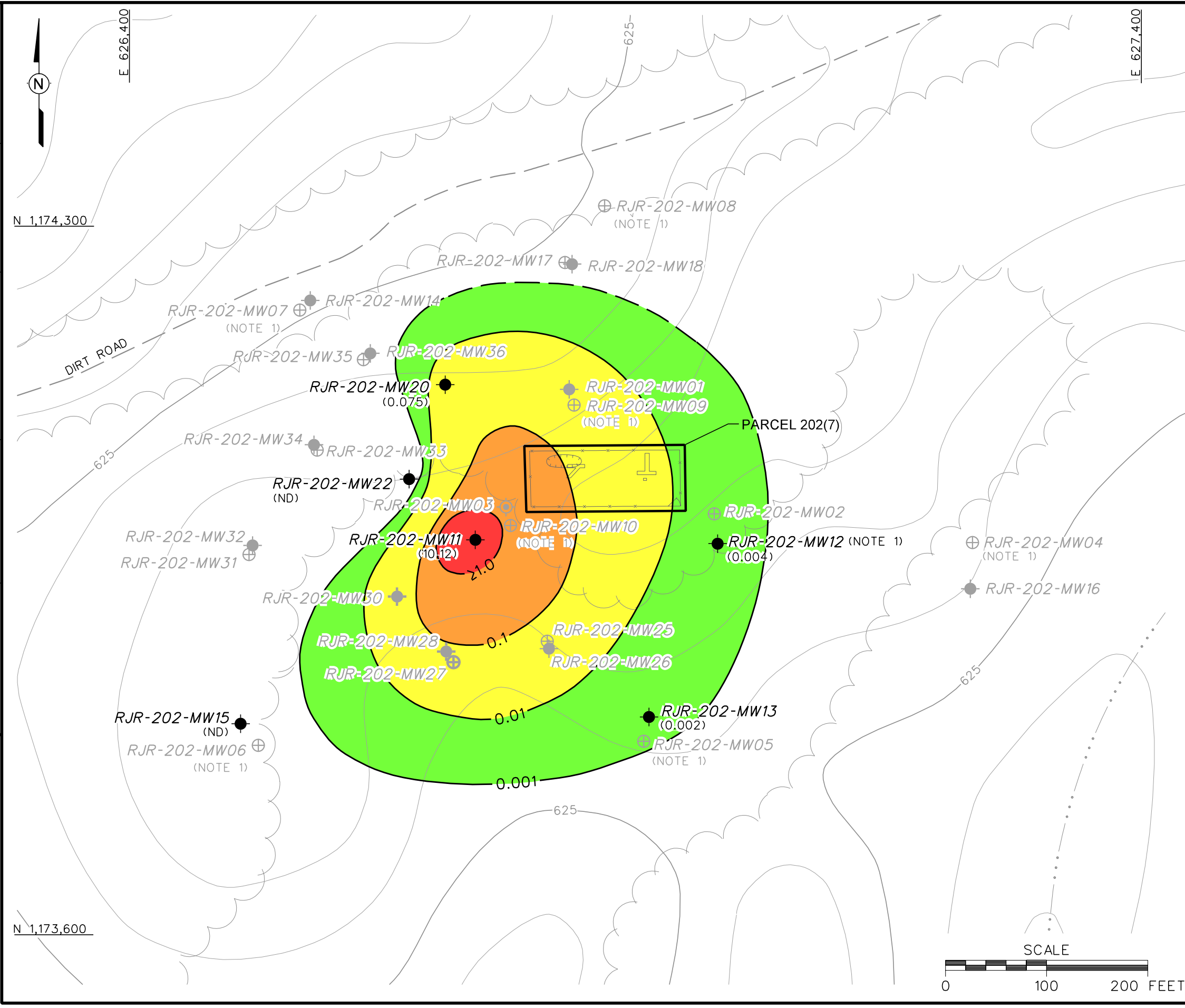
- NOTES:**
1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.
 2. SHADED WELL LOCATIONS NOT INCLUDED IN ZONE A.
 3. CHLORINATED VOCs CALCULATED EXCLUDING COMMON LABORATORY CONTAMINANT METHYLENE CHLORIDE

FIGURE 4-9
ISOCONCENTRATION MAP
CHLORINATED VOCs IN GROUNDWATER
(ZONE A)
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018



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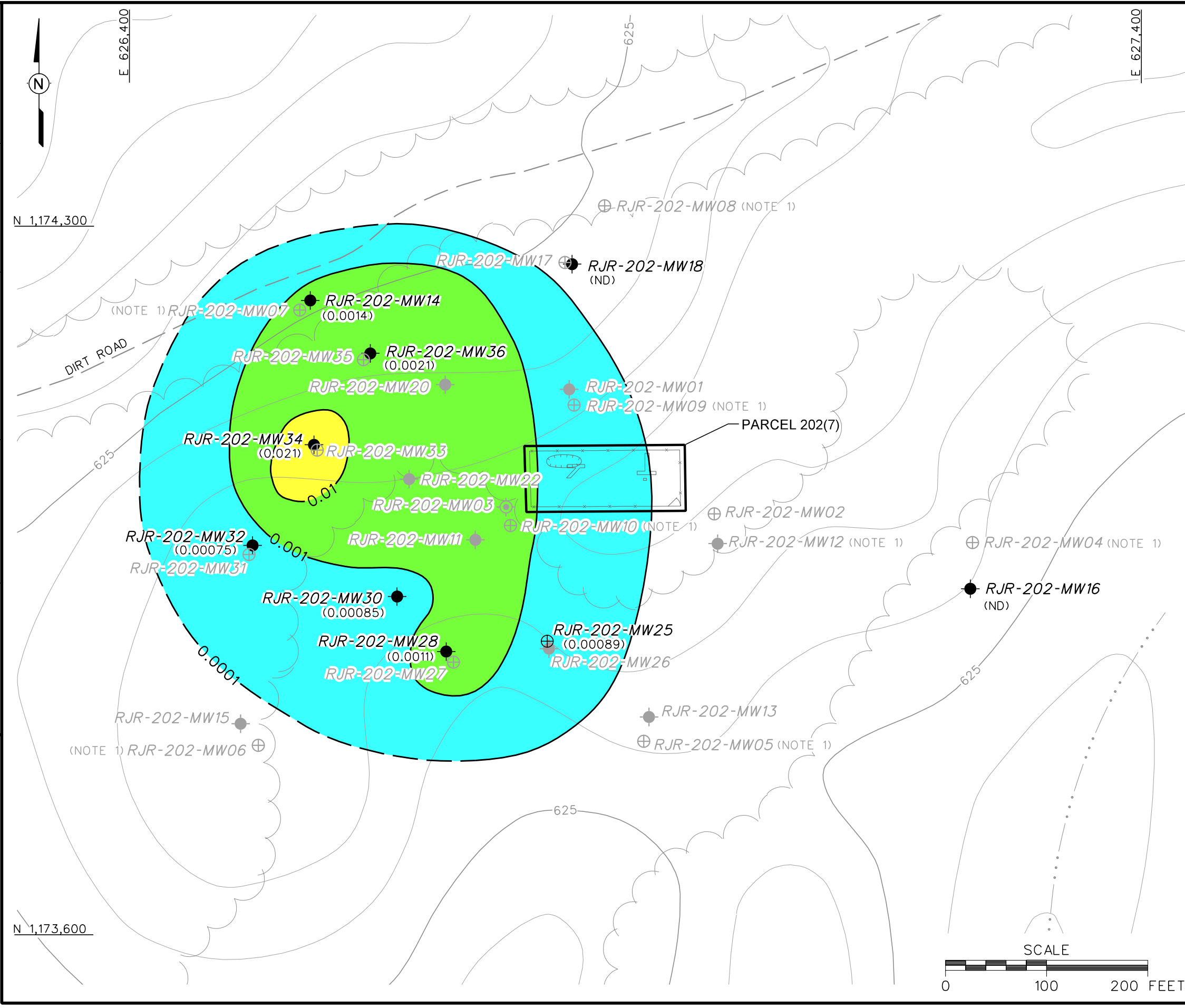


- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION
 - CHLORINATED VOCs CONCENTRATION (mg/L) (DASHED WHERE INFERRED)
 - CONCENTRATION IN MILLIGRAMS PER LITER (mg/L)
 - (ND) NOT DETECTED

- NOTES:**
1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.
 2. SHADED WELL LOCATIONS NOT INCLUDED IN ZONE B.
 3. CHLORINATED VOCs CALCULATED EXCLUDING COMMON LABORATORY CONTAMINANT METHYLENE CHLORIDE

FIGURE 4-10
ISOCONCENTRATION MAP
CHLORINATED VOCs IN GROUNDWATER
(ZONE B)
RANGE J - PELHAM RANGE
PARCEL 202(7)

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- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION
 - CHLORINATED VOCs CONCENTRATION (mg/L) (DASHED WHERE INFERRED)
 - (0.0011) CONCENTRATION IN MILLIGRAMS PER LITER (mg/L)
 - (ND) NOT DETECTED

- NOTES:**
1. SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.
 2. SHADED WELL LOCATIONS NOT INCLUDED IN ZONE C.
 3. CHLORINATED VOCs CALCULATED EXCLUDING COMMON LABORATORY CONTAMINANT METHYLENE CHLORIDE

FIGURE 4-11
ISOCONCENTRATION MAP
CHLORINATED VOCs IN GROUNDWATER
(ZONE C)
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

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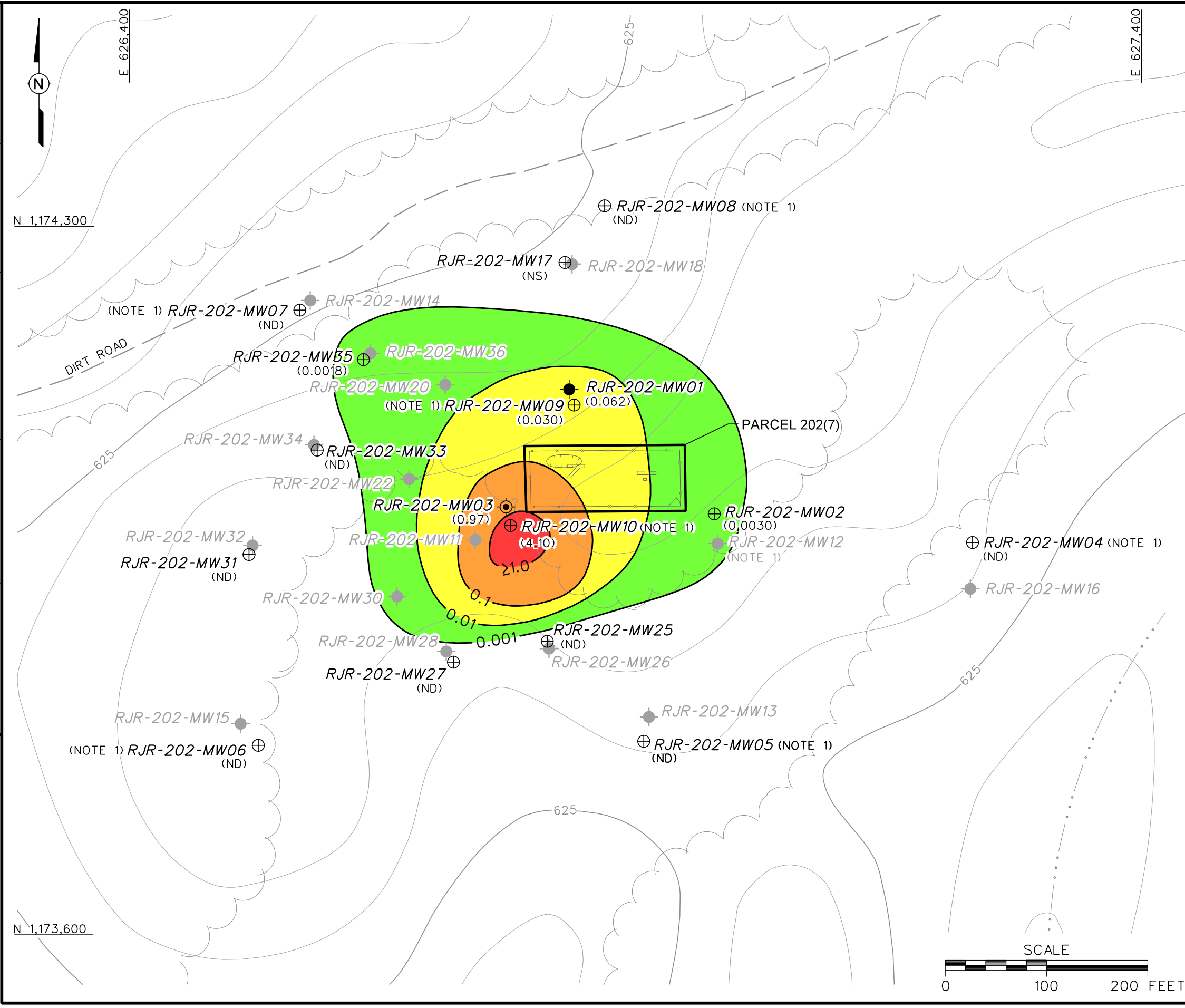
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INITIATOR: D. ALLAN
PROJ. MGR.: J. YACOB

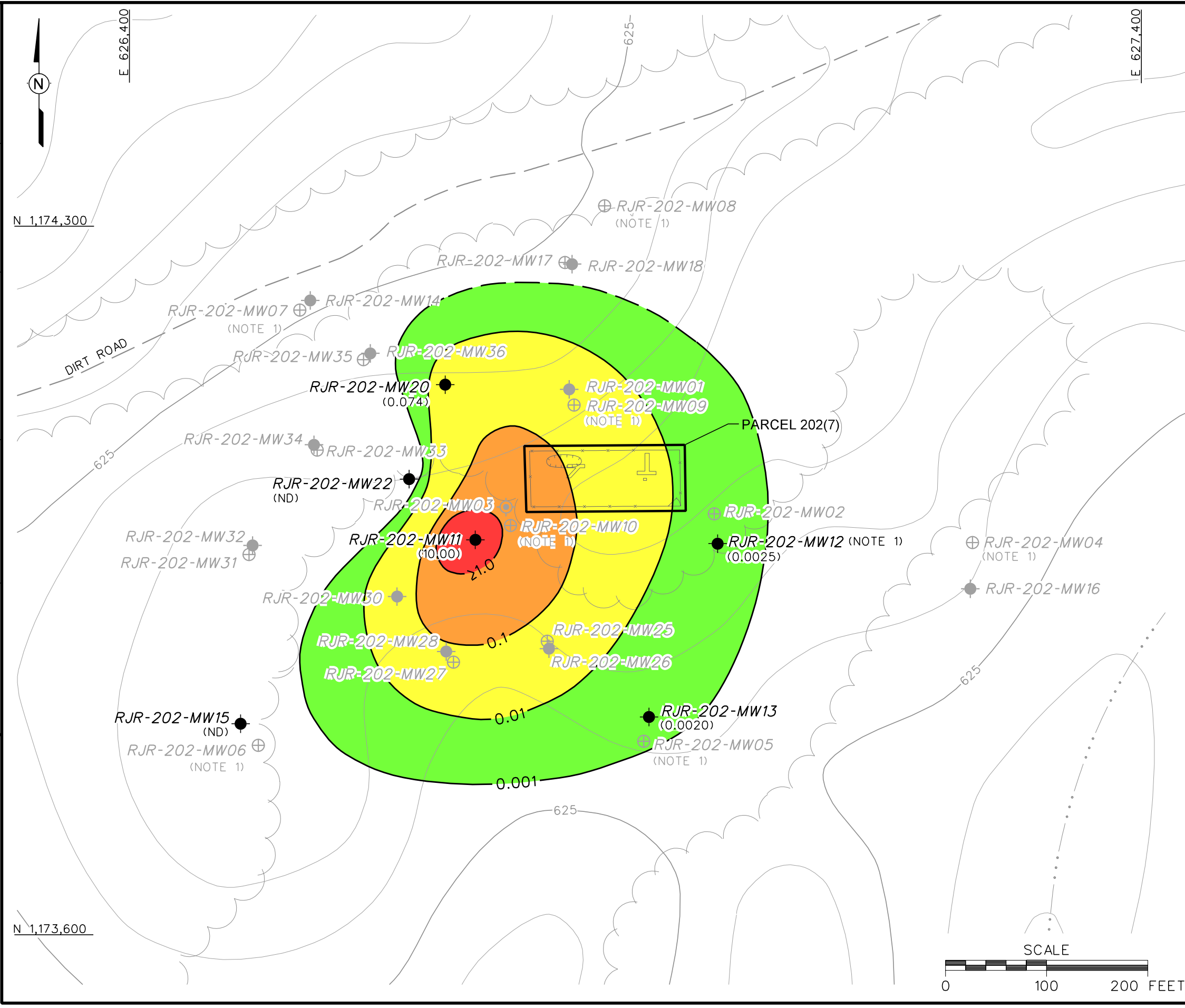
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- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION
 - CARBON TETRACHLORIDE CONCENTRATION (mg/L) (DASHED WHERE INFERRED)
 - (0.0018) CONCENTRATION IN MILLIGRAMS PER LITER (mg/L)
 - (ND) NOT DETECTED
 - (NS) NOT SAMPLED

- NOTES:**
- SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.
 - SHADED WELL LOCATIONS NOT INCLUDED IN ZONE A.

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PROJ. MGR.: J. YACOB
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PROJ. NO.: 774645



LEGEND

- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
- TREES / TREELINE
- PARCEL BOUNDARY
- FENCE
- FORMER SOIL / DRUM DISPOSAL PIT
- FORMER TRENCH EXCAVATION
- RESIDUUM/BEDROCK MONITORING WELL LOCATION
- RESIDUUM MONITORING WELL LOCATION
- BEDROCK MONITORING WELL LOCATION
- CARBON TETRACHLORIDE CONCENTRATION (mg/L) (DASHED WHERE INFERRED)
- (0.0025) CONCENTRATION IN MILLIGRAMS PER LITER (mg/L)
- (ND) NOT DETECTED

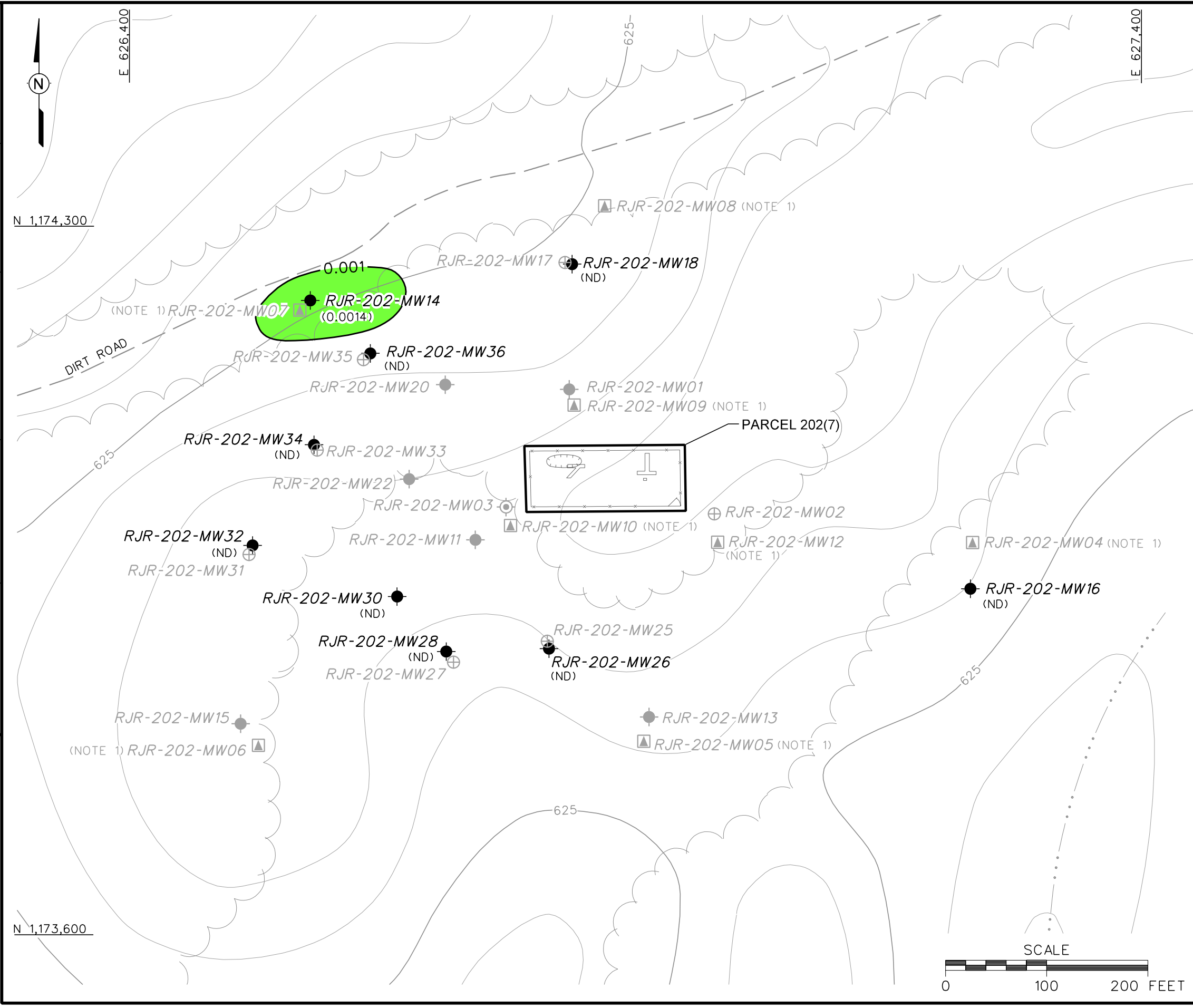
NOTES:

- SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.
- SHADED WELL LOCATIONS NOT INCLUDED IN ZONE B.

FIGURE 4-13
ISOCONCENTRATION MAP
CARBON TETRACHLORIDE
IN GROUNDWATER (ZONE B)
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

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INITIATOR: D. ALLAN
PROJ. MGR.: J. YACOB
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- LEGEND**
- TOPOGRAPHIC CONTOURS (CONTOUR INTERVAL - 5 FOOT)
 - TREES / TREELINE
 - PARCEL BOUNDARY
 - FENCE
 - FORMER SOIL / DRUM DISPOSAL PIT
 - FORMER TRENCH EXCAVATION
 - RESIDUUM/BEDROCK MONITORING WELL LOCATION
 - RESIDUUM MONITORING WELL LOCATION
 - BEDROCK MONITORING WELL LOCATION
 - CARBON TETRACHLORIDE CONCENTRATION (mg/L) (DASHED WHERE INFERRED)
 - (0.0014) CONCENTRATION IN MILLIGRAMS PER LITER (mg/L)
 - (ND) NOT DETECTED

- NOTES:**
- SURFACE AND SUBSURFACE SOIL SAMPLES ALSO COLLECTED AT THIS LOCATION.
 - SHADED WELL LOCATIONS NOT INCLUDED IN ZONE C.

FIGURE 4-14
ISOCONCENTRATION MAP
CARBON TETRACHLORIDE
IN GROUNDWATER (ZONE C)
RANGE J - PELHAM RANGE
PARCEL 202(7)

U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018



Sulfate/Sulfite. Thirty groundwater samples collected during Phase II of the supplemental RI were analyzed for sulfate. Sulfate was detected in all of the samples at concentrations ranging from 0.443 mg/L in (RJR-202-MW18) to 28.4 mg/L (in RJR-202-MW34). Sulfite was not detected in any of the samples.

Total Suspended Solids. Thirty groundwater samples collected during Phase II of the supplemental RI were analyzed for total suspended solids (TSS). TSS concentrations ranged from 12 to 18 mg/L, as summarized in Appendix H.

Total Dissolved Solids. Thirty groundwater samples collected during Phase II of the supplemental RI were analyzed for total dissolved solids (TDS). TDS concentrations ranged from 70 to 468 mg/L, as summarized in Appendix H.

Hardness. Thirty groundwater samples collected during Phase II of the supplemental RI were analyzed for hardness. Hardness values (as calcium carbonate) ranged from 38.5 to 157 mg/L, as summarized in Appendix H.

4.3.4 Drum Sample Analytical Results

One sample of liquid was collected from an unmarked 55-gallon drum located southwest of the fenced area at Range J (Figure 2-2). The drum sample was analyzed for metals, VOCs, and SVOCs, as summarized below. The drum sample results are included in Appendix H.

Metals. Seventeen metals were detected in the drum sample collected at Range J: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, sodium, and zinc.

VOCs. VOCs were not detected in the drum sample.

SVOCs. SVOCs were not detected in the drum sample.

Based on the analytical results, the drum's contents (approximately 20 gallons) were disposed as nonhazardous liquid IDW following procedures specified in the SAP (see Section 2.7). The drum was washed and disposed as scrap metal. The crushed drum, found near the intact drum that was sampled, was also disposed as scrap metal.

5.0 Contaminant Fate And Transport

5.1 Introduction

Two major factors affecting the fate and transport of a chemical when released to the environment are its mobility and its persistence. Mobility is a measure of the tendency for a chemical to migrate through the environment and is affected by the physical/chemical characteristics of the chemical. The major processes at work in the natural environment include aqueous solubility, volatilization, sorption, hydrolysis, photolysis, and oxidation rates. Persistence, a measure of the time a chemical remains in the environment, is influenced by many of the same factors affecting chemical mobility (e.g., photolysis, hydrolysis, and oxidation). Persistence is also a function of chemical-biological interactions in the environment, such as biodegradation and/or bioaccumulation.

Potential routes of transport and transport mechanisms that may be applicable to the contaminants at Range J are presented and evaluated in Section 5.2. The persistence of chemicals detected at the site and factors affecting the environmental fate and transport process are presented in Section 5.3. Table 5-1 lists the physical and chemical properties of the organic chemicals detected above ESVs or SSSLs at the site. Table 5-2 provides data on the distribution coefficient for metals. Section 5.4 evaluates the direction and rate of contaminant migration at Range J and includes Table 5-3, which summarizes the rate and distance of migration estimated for organic chemicals cited in Table 5-1. Also included in Section 5.4 are geologic cross sections of the site showing the vertical and horizontal distribution of total VOCs, chlorinated VOCs, and carbon tetrachloride.

For the purposes of this RI report, only a qualitative evaluation of potential routes of migration, contaminant persistence, and contaminant migration is presented. Fate and transport modeling were not included in the scope of work.

5.2 Potential Routes of Migration

Contaminants can be transported from their source(s) to other areas as a result of several potential transport mechanisms and migration pathways. The migration of contaminants at a site is dependent on factors that include 1) site characteristics such as soil and bedrock conditions, groundwater and surface water conditions, and climatic conditions; and 2) contaminant characteristics. As part of the evaluation process for Range J, potential migration pathways considered are:

- Fugitive dust emissions and volatilization from soil
- Erosion and surface water runoff

Table 5-1

Physical and Chemical Parameters Affecting Environmental Fate of Organic Chemicals
Range J, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

Compound	Molecular Wt. (g/mole)	Water Solubility (mg/L @20°C)	Vapor Pressure (mm Hg @20°C)	Octanol-Water Partition Coeff. (Log K _{ow})	Adsorption Coeff. (Log K _{oc})	K _{oc} -Calc. (mL/g)	K _{oc} -Meas. (mL/g)	Henry's Law Constant (atm-m ³ /mol)	BCF (calc.)	Specific Gravity
Volatiles										
Acetone	58.09	1.00 E+06 ^c	2.70E+02 ^c	-0.24 ^e	-0.24 ^e	0.57 ^e	2.2 ^e	2.06 E-05 ^c	-	0.7899
Chloroform	119.38	8.20 E+03 ^a	1.51E+02 ^a	1.92 ^e	1.60 ^e	39.8 ^e	52.5 ^e	2.87 E-03	3.75	1.4832
1,2-Dichloroethane	98.96	8.70 E+03 ^a	7.87E+01 ^b	1.48 ^b	1.24 ^e	17.4 ^e	38 ^e	9.77E-04 ^b	8 ^b	1.2351
1,1,2,2-Tetrachlorethane	167.9	2.90 E+03 ^a	5.0E+00 ^a	2.39 ^b	1.97 ^e	93 ^e	79 ^e	4.55E-04 ^b	42 ^a	1.5953
Trichloroethene	131.4	1.10E+03(25C) ^b	6.9E+01 ^b	2.71 ^e	2.22 ^e	166 ^e	94.3 ^e	1.03E-02 ^b	10.6 ^c	1.4642
Tetrachloroethene	165.83	2.00 E+02 ^a	1.85E+01(25C)	2.67 ^e	2.19 ^e	155 ^e	265 ^e	1.49E-02 ^b	39-226 ^b	1.6227
Carbon Tetrachloride	153.84	8.05 E+02 ^b	9.00E+01 ^a	2.73 ^e	2.24 ^e	174 ^e	152 ^e	3.04E-02(24.8C) ^b	19 ^c	1.594
Benzene	78.12	1.78 E+03 ^e	9.52E+01	2.13 ^e	1.77 ^e	58.9 ^e	61.7 ^e	5.50E-03	5.2 ^c	0.8765
Semivolatiles										
bis(2-ethylhexyl)phthalate	391	3.00 E-01(25) ^b	6.45 E-06 ^b	7.30 ^e	7.18 ^e	1.51E+07 ^e	1.11E+05 ^e	1.1 E-05 ^b	2-4 ^b	0.99

References:^a Mabey, W. R., 1982.^b Howard, P. H., 1990.^c U.S. Environmental Protection Agency, 1986.^d U.S. Environmental Protection Agency, 1992.^e U.S. Environmental Protection Agency, 1996.

g/mole = Grams per mole.

mg/L = Milligrams per liter.

°C = Degrees Celsius.

mm Hg = Millimeters of mercury.

K_{ow} = Octanol-water coefficient.K_{oc} = Organic partitioning coefficient.

mL/g = Milliliters per gram.

atm-m³/mol = Cubic meter per mole per atmosphere.

BCF = Bioconcentration factor.

Table 5-2

**Distribution Coefficient, K_d
Range J, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

Metal	K_d Geometric Mean	K_d Range	No. Values	Potential Groundwater Mobility
Antimony	45			Medium
Arsenic	200			Low
Arsenic (+3)	3.3	1.0-8.3	19	Medium
Barium	60			Medium-Low
Beryllium	650			Low
Cadmium	6.4	1.26-26.8	28	Medium
Chromium	850			Low
Chromium (+3)	--	--	--	--
Chromium (+6)	37	1.2-1800	18	Medium
Cobalt	47			Medium
Copper	35			Medium
Lead	900			Low
Manganese	65			Medium-Low
Mercury	10			Medium
Nickel	150			Low
Selenium	300			Low
Silver	46	10-1,000	16	Medium
Thallium	1,500			Low
Vanadium	1,000			Low
Zinc	38	0.1-8,000	146	Medium

Units are in milliliters per gram.

"--" - Not available.

References:

Baes and Sharp, 1983.

Baes et al., 1984.

Table 5-3

Contaminant Migration Rates
Range J, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

Contaminant	f_{oc} (kg/kg)	K_{oc} (mL/g)	K_d	D_b (g/cm ³)	n	k (ft/day)	I (avg)	V (ft/day)	R_d	V_c (ft/day)	V_c (ft/year)	Distance Migrated in 50 Years (ft)
Residuum												
Acetone	0.006	0.57	0.0034	1.6	0.4	3.04 E+00	0.00156	0.01581	1.014	0.01559	5.69	284.5
Benzene	0.006	58.9	0.3534	1.6	0.4	3.04 E+00	0.00156	0.01581	2.414	0.00655	2.39	119.5
Chloroform	0.006	39.8	0.2388	1.6	0.4	3.04 E+00	0.00156	0.01581	1.955	0.00809	2.95	147.6
1,2-Dichloroethane	0.006	17.4	0.1044	1.6	0.4	3.04 E+00	0.00156	0.01581	1.418	0.01115	4.07	203.5
1,1,2,2-Tetrachlorethane	0.006	93	0.558	1.6	0.4	3.04 E+00	0.00156	0.01581	3.232	0.00489	1.79	89.3
Carbon Tetrachloride	0.006	152	0.912	1.6	0.4	3.04 E+00	0.00156	0.01581	4.648	0.0034	1.24	62.1
Trichloroethene	0.006	94	0.564	1.6	0.4	3.04 E+00	0.00156	0.01581	3.256	0.00486	1.77	88.6
Tetrachloroethene	0.006	155	0.93	1.6	0.4	3.04 E+00	0.00156	0.01581	4.72	0.00335	1.22	61.1
Bis(2-ethylhexyl)phthalate	0.006	1.11E+05	666	1.6	0.4	3.04 E+00	0.00156	0.01581	2665	0.000006	0.002	0.108
Transitional												
Carbon Tetrachloride	0.006	152	2.28	2.43	0.4	1.66E+00	0.00243	0.01345	14.851	0.0009	0.33	16.5
Bedrock												
Carbon Tetrachloride	0.015	152	2.28	2.43	0.2	6.52 E+00	0.00243	0.10562	28.702	0.00368	1.34	67.2
Trichloroethene	0.015	94	1.41	2.43	0.2	6.52 E+00	0.00243	0.10562	18.132	0.00583	2.13	106.3
Tetrachloroethene	0.015	155	2.325	2.43	0.2	6.52 E+00	0.00243	0.10562	29.249	0.00361	1.32	65.9

f_{oc} , Organic carbon content in soil and bedrock.

K_d , soil adsorption or distribution coefficient = $(K_{oc})(f_{oc})$; relation valid as long as solute present is at concentrations below about 1/2 of its solubility.

Percentage of organic carbon assumed at 0.6% ($f_{oc} = 0.006$) EPA default for soils.

Percentage of organic carbon assumed at 1.5% ($f_{oc} = 0.015$) for sedimentary rocks; Trask and Patnode (1942).

V_c , average velocity of solute = V / R_d .

V , average linear groundwater velocity = $k(I) / n_e$

I = horizontal hydraulic gradient

k = hydraulic conductivity

n_e = effective porosity = $n - S$, where S is specific retention or storativity.

R_d , retardation coefficient = $1 + (K_d)(D_b/n)$

D_b = bulk density, g/cm³:

D_b assumed for limestone @ 2.43 g/cm³

D_b assumed for shales @ 2.3 g/cm³

D_b assumed for sandstones @ 2.1 g/cm³.

n = total porosity:

n assumed @ 40% for silts and clays

n_e estimated @ 30% for residuum, Walton (1988), Domenico and Schwartz (1990)

n assumed @ 20% for bedrock

n_e estimated @ 15% for limestone, Walton (1988), Domenico and Schwartz (1990).

avg = Average.

ft = Feet.

ft/day = Feet per day.

ft/year = Feet per year.

g/cm³ = Grams per cubic centimeter.

kg = Kilogram per kilogram.

mL/g = Milliliters per gram.

- Surface water and sediment transport
- Infiltration and leaching from surface soils to subsurface soils to groundwater
- Transport within the groundwater flow system
- Discharge of groundwater to the surface
- Bioaccumulation.

5.2.1, Dust Emission and Volatilization

Contaminants adsorbed to surface soils could be transported from source areas by fugitive dust generation and entrainment by wind. Subsequent atmospheric mixing could transport contaminant-associated particulates to other parts of Range J or to off-site locations.

Contaminant adsorbed dust could also be released to the atmosphere through construction activities. However, most of the surface area of Range J is best characterized as mixed deciduous/coniferous forest, with the exception of the area within the chain-link fence, where grasses dominate. In view of this, the generation of fugitive dust and subsequent transfer by wind is not anticipated to be a significant transport mechanism. No major construction activities have occurred at the site.

Site-related contamination could be released through volatilization into the air. This migration path would be limited primarily to volatile compounds in the surficial soil (0 to 2 feet). Some inorganic elements, such as mercury, are also volatile. All organic constituents detected in surface soils were below SSLs. Acetone was detected above its ESV in one of the surface soil samples; the arithmetic mean concentration of acetone was below the ESV.

5.2.2 Erosion and Surface Water Runoff

Erosion and surface water runoff have the potential to transfer contaminants either in a dissolved state or adsorbed to soil particulates or organic matter. Transport routes follow local topography and established drainage systems, if present at a site. Although the potential for surface water runoff exists at Range J, there are no surface water bodies in close proximity. In addition, surface topography at the site is generally flat over three-fourths of the area and slopes to the northwest in the western portion of the site. Because of the subdued topography and absence of surface water drainage systems, erosion and surface runoff are not considered a significant transport mechanism at Range J.

5.2.3 Surface Water and Sediment Transport

Due to the absence of a surface water body in the near vicinity of Range J, surface water and sediment fate and transport mechanisms of constituents detected at Range J are not considered.

5.2.4 Leaching from Surface and Subsurface Soils to Groundwater

Migration of soil contamination through percolation of rainwater and movement of the leachate into groundwater is considered the most significant route of contaminant migration at Range J. In surface soils, 14 VOCs were detected at concentrations below SSSLs, and acetone was detected in one soil sample at a concentration below its SSSL but exceeding its ESV. The only SVOCs detected in surface soils were two phthalates (di-n-butylphthalate and bis[2-ethylhexyl]phthalate), both of which are common field and laboratory contaminants. These compounds were detected in either the associated laboratory or field blanks. Neither compound was detected at a concentration exceeding its SSSL or ESV. Eleven VOCs were detected in subsurface soil samples at the site. All detections were at concentrations below SSSLs. Four SVOCs were detected at concentrations below SSSLs in subsurface soil samples: benzo(a)anthracene, chrysene, and the same two phthalates detected in surface soil samples. Benzo(a)anthracene and chrysene are PAHs and are characterized by low water solubilities and relatively high organic partitioning coefficients. Because of this combination of parameters, PAHs are more likely to adsorb to soil, and leaching of these compounds to the groundwater is considered unlikely. However, these chemical characteristics may be overridden by the strongly acidic nature of the soils described for the site.

As discussed above, VOC concentrations in surface and subsurface soils were below SSSLs. Acetone, a common laboratory contaminant, was detected in one surface soil sample at a concentration exceeding its ESV. The presence of VOCs at reduced concentrations may be taken as an indication of either an original limited release of volatiles, or that leaching of contaminants from surface and subsurface soils has occurred. Precipitation percolating through the soil in the unsaturated zone has partitioned contaminants from the soil matrix into the leachate. The absence of significant VOC concentrations in the upper soil profile and residuum is a qualitative indication of the relative ease with which VOCs may partition.

5.2.5 Groundwater Transport

Contaminants in groundwater can be transported in either a dissolved phase or a soil-adsorbed phase. Soluble chemical constituents will be transported in the direction of groundwater flow. Based on the groundwater monitoring well data, groundwater flow at the site appears to be in an overall direction to the west-northwest in both residuum and bedrock. The difference in hydraulic head across the site in both aquifers is on the order of 1 foot or less, indicating an almost flat water table surface and a very low horizontal hydraulic gradient (Table 3-1). Calculations of vertical head gradients between residuum and bedrock presented in Table 3-2 are relatively small and suggest that the residuum and bedrock aquifers are in communication.

Soluble chemical constituents entering the groundwater system in either residuum or bedrock would flow in the direction of groundwater movement. The rate of transport of these chemical constituents in the residuum is determined, in part, by equilibrium partitioning between the mobile aqueous phase and the soil particles of the residuum. The degree of partitioning in the residuum is governed mainly by the organic matter content. In bedrock, the degree of partitioning is substantially less. Release and transport to the groundwater system is the principal migration pathway and mechanism of on-site contaminant migration and potential off-site contaminant transport of both dissolved organic and inorganic compounds detected at Range J.

5.2.6 Discharge of Groundwater to the Surface

There is no known surface water discharge in the form of springs or wetlands at Range J. No standing bodies of water (e.g., ponds) or flowing surface waters are present where hydraulic connectivity to the residuum or bedrock aquifers occurs. Therefore, discharge of contaminated groundwater to the surface is not considered as a transport mechanism.

5.2.7 Bioaccumulation

Many organic and inorganic chemicals have the potential to bioconcentrate and bioaccumulate in plants and/or animals. This may occur through direct bioconcentration from an aqueous medium, root uptake from soils to plants, ingestion of water, incidental ingestion of soils and sediments, and ingestion of contaminated plants or animal prey as food sources. These pathways are discussed in detail in Chapter 7.0.

5.3 Contaminant Persistence

Factors affecting environmental persistence and mobility processes are defined in this section. These factors deal with the chemical and physical reactions that take place in the environment and their effect on contaminant transport. Parameters governing the environmental fate and transport data for the chemicals detected at Range J are presented in Table 5-1.

The chemicals are divided into two groups: organic and inorganic. The organic constituents are further divided where possible into groups that share similar characteristics.

5.3.1 Chemical and Physical Processes Affecting Fate and Transport

The most important fate and transport process for organic constituents detected at Range J is likely to be aqueous solubility. The greater the solubility of an organic constituent, the greater the potential for migration via groundwater transport. For inorganic constituents, the ability to

enter the groundwater transport system is largely determined by the distribution coefficient of the chemical.

A number of measurable chemical parameters are used to determine the rate and extent of a chemical process. The parameters include aqueous solubility, Henry's Law constants, diffusion coefficients, vapor pressures, adsorption/partitioning coefficients, and degradation rates. These parameters can be used to estimate the quantity of contaminants that will go into solution; rates of volatilization; rates of diffusion; quantity of contaminants adsorbed or desorbed onto, or released from, soil particles; and rates of degradation.

5.3.1.1 Aqueous Solubility

Aqueous solubility is the maximum amount of a chemical that will dissolve in pure water at a specified temperature. The solubility of most organic compounds ranges from approximately 1 to 10,000 mg/L at ambient temperatures. Aqueous solubility is an important determinant of chemical concentration and residence time in water. Highly soluble chemicals readily dissolve in water and remain in solution; chemicals with low solubility tend to adsorb to solids or form nonpolar phases.

5.3.1.2 Volatilization

Volatilization is the movement of a chemical from the surface of a liquid or solid matrix to a gas or vapor phase. Volatilization losses to the air are related to the chemical concentration, molecular weight, solubility, vapor pressure, and ambient temperature. The tendency for a chemical to volatilize from water can be estimated from its Henry's Law constant, H ($\text{atm}\cdot\text{m}^3/\text{mol}$). This measure relates the equilibrium concentrations of a compound in the dissolved and vapor phases and is a constant at a given temperature. H relates the partial pressure of a gas above a liquid and a mole fraction of the gas dissolved in the liquid and affects the rate and extent of volatilization. Lyman et al. (1982) classified compounds based on their H value, as readily (greater than $10^{-3} \text{ atm}\cdot\text{m}^3/\text{mol}$), significantly (10^{-3} to $10^{-5} \text{ atm}\cdot\text{m}^3/\text{mol}$), or limitedly (less than $10^{-5} \text{ atm}\cdot\text{m}^3/\text{mol}$) volatilized.

5.3.1.3 Diffusion

Diffusion coefficients are a measure of the diffusive mobility of a contaminant in solution. As the diffusion coefficient increases, so does the rate of diffusion. Diffusion coefficients are temperature dependent and increase with temperature. The diffusion coefficient is important in determining vapor-phase diffusion. By definition, vapor pressure is the pressure exerted by a chemical vapor in equilibrium with its solid or liquid form at any given temperature. It is used to

calculate the rate of volatilization of a pure substance or in estimating a Henry's Law constant for chemicals with low water solubility. The higher the vapor pressure, the more likely a chemical is to exist in a gaseous state.

5.3.1.4 Adsorption/Desorption

Adsorption/desorption is the binding of a chemical to (adsorption) or its release from (desorption) a solid matrix (e.g., soils, sediments, and suspended solids). Partition coefficients are important measures of sorptive characteristics and help define the relative concentrations of a given chemical in two phases or matrices. Partition coefficients are expressed as concentration ratios between two phases and include:

- Organic Partitioning or Adsorption Coefficient, K_{oc} – Provides a measure of the extent of chemical partitioning between organic carbon and water at equilibrium. The greater the K_{oc} of a chemical, the more likely that chemical is to adsorb to soil or sediment rather than remain dissolved in water.
- Soil Adsorption or Distribution Coefficient, K_d – Provides a measure of the extent of chemical partitioning between soil or sediment and water, unadjusted for dependence on organic carbon. Adsorption coefficients are site specific and specific to soil types. K_d can be normalized for organic carbon content by the soil adsorption coefficient (K_{oc}) times the soil organic carbon content (f_{oc}) (mg of organic carbon/mg soil). If site-specific values cannot be obtained, values can be estimated from the organic carbon content, carbon content, and the octanol-water coefficient. The higher the K_d value, the more likely a chemical is to bind to soil or sediment rather than to remain dissolved in water.
- Octanol-Water Partition Coefficient, K_{ow} – Provides a measure of the extent of chemical partitioning between water and octanol at equilibrium. The greater the K_{ow} value, the more likely a chemical is to partition to octanol rather than to remain in water. K_{ow} can be used to estimate K_{oc} and to predict bioconcentration in living organisms. Chemicals with a log K_{ow} less than 2.5 rarely bioaccumulate significantly in plants or animals and have a high water solubility.

5.3.1.5 Degradation Rate

Degradation rate is a measure of the rate at which a contaminant breaks down into other, simpler compounds. Types of degradation rates can be broken into four categories: hydrolysis rates, photolysis rates, oxidation/reduction rates, and biodegradation rates.

- Hydrolysis is the reaction of a chemical with hydrogen ions or the hydroxyl radicals, resulting in the degradation or structural modification of the chemical.

The extent of a chemical's hydrolytic reaction is a function of the molecular structure of the chemical and the pH of the environment.

- Photolysis is a chemical degradation process caused by sunlight. The rate of degradation from photochemical reactions depends on the chemical's molecular structure, the proximity and character of the radiant energy (light source), and the presence of other reactive compounds.
- Oxidation/Reduction is a chemical reaction in which a chemical either loses an electron (oxidation) or adds an electron (reduction). Oxidation/reduction rates of chemicals are significant, in that they influence both the environmental mobility and fate of a chemical.
- Biodegradation of organic compounds can transform them through various reactions. The chemical processes that remove or transform compounds can involve oxidation or reduction, depending on whether aerobic or anaerobic conditions exist. The rate of biodegradation is influenced by numerous parameters, including but not limited to groundwater temperature, pH, dissolved oxygen, organic matter content, phosphate, sulfate, and nitrate concentrations.

5.3.2 Contaminant Fate and Transport

Contaminant fate and transport of VOCs, SVOCs, and inorganic compounds are discussed in the following sections.

5.3.2.1 Volatile Organic Compounds

VOCs were detected in surface soils, subsurface soils, and groundwater at Range J, as summarized in Chapter 4.0. None of the 14 VOCs detected in surface soils or the 11 VOCs detected in subsurface soils exceeded SSSLs. Acetone exceeded its ESV in one surface soil sample. Nineteen VOCs were detected in groundwater, of which seven exceeded their SSSLs. Table 5-1 presents the physical and chemical parameters governing the environmental fate and transport of the one VOC that exceeded its ESV and the seven VOCs that exceeded SSSLs. These VOCs are divided into three primary groups of organic constituents: ketones, aromatic hydrocarbons, and chlorinated aliphatic hydrocarbons.

Ketones. Acetone was the only ketone detected above its ESV in one surface soil sample. Ketones are highly soluble in water and tend to have a low to moderate retardation or affinity to soils. If released to soil, acetone will both volatilize and leach into the ground. Acetone readily biodegrades in soils and if released into water. Based upon the solubility and other chemical properties, ketones tend to be mobile in groundwater; however, the one low concentration detected in surface soil has not been matched by a similar detection in subsurface soils or

groundwater. Typical releases of ketones appear to be as minor constituents mixed with other chemicals.

Aromatic Hydrocarbons. Benzene was the only aromatic hydrocarbon detected above SSSLs at Range J. Aromatic VOCs are not likely to be persistent in soils and may be mobilized to groundwater by infiltration. If released to the soil, they are subject to rapid volatilization near the surface; that portion of a release not volatilized will be mobile to highly mobile and may leach to the groundwater. Benzene has a moderate to high solubility in water and is not expected to significantly adsorb to soils, bioconcentrate, or hydrolyze. Benzene has fairly low K_{ow} and K_{oc} coefficients, indicating a low affinity for adsorption to organic matter. Slow biodegradation of benzene occurs via microbial processes. Active biological degradation is often indicated by reduced dissolved oxygen and localized reducing conditions. Under anaerobic conditions, slow degradation has been reported.

Chlorinated Aliphatic Hydrocarbons. Chlorinated ethanes and ethenes, carbon tetrachloride, and chloroform were detected at concentrations above SSSLs in groundwater at Range J. None were detected at concentrations exceeding SSSLs in surface or subsurface soils. Chlorinated hydrocarbons tend to have high solubility in water. The high solubilities are, in part, due to their relatively low molecular weights and high polarity. The constituents tend to have a low affinity for soils and are generally highly mobile through the soil column and most aquifers. Low K_{oc} values would suggest that sorption to soils would be expected to be relatively minor; thus, transport in groundwater is expected to be the dominant transport pathway. The main degradation process acting to reduce contaminant concentration is biodegradation. The most important process for natural biodegradation is reductive dechlorination. This process occurs by sequential dechlorination from PCE to TCE to dichloroethene to vinyl chloride to ethene. The contaminant suites observed at the site indicate that anaerobic degradation may be occurring in groundwater at the site. Photolysis and hydrolysis are not expected to be significant removal mechanisms.

5.3.2.2 Semivolatile Organic Compounds

SVOCs were detected in surface and subsurface soils at Range J. No surface soil concentrations exceeded SSSLs or ESVs; two phthalates commonly associated with field and laboratory contamination were detected and, in general, qualified as being detected in associated laboratory or field blanks. Four SVOCs were detected in subsurface soils at concentrations below SSSLs. The same two phthalates detected in the surface soils were also detected in the subsurface soils and similarly qualified. The other two SVOCs were PAHs (benzo[a]anthracene and chrysene).

In groundwater, three SVOCs were detected. The phthalate bis(2-ethylhexyl) phthalate was detected above its SSSL, and two phenolic compounds (phenol and 2-nitrophenol) were detected below SSSLs.

Phthalate Esters. Although most of the detections are “B”- or “J”-flagged detections, the presence of bis(2-ethylhexyl)phthalate above its SSSL in one groundwater sample requires consideration of its environmental fate. Although phthalate esters are considered to be fairly soluble, their solubility is low compared to the VOCs detected at the site. Because of this generally low solubility, runoff and ground water transport will not be an important environmental process. Some phthalate esters readily adsorb to organic matter and soil particles. The tendency to adsorb is reflected by high K_{oc} and K_{ow} partition coefficients. Biodegradation is a significant fate process. Phthalate esters are degraded under most aerobic and anaerobic conditions by microbial populations. Due to their low volatilization rate, indicated by their Henry’s Law constants and vapor pressures, volatilization will not be a significant environmental fate process. Photolysis/hydrolysis will also be limited and of little importance.

5.3.2.3 Inorganics

Many of the chemical and physical processes governing fate and transport discussed in Section 5.3.1 also influence inorganic chemicals. In addition to those processes, complexation, precipitation/co-precipitation, and cationic exchange are significant factors unique in influencing the persistence and movement of inorganic chemicals (Alloway, 1990). A brief discussion of these factors is presented in this section. The distribution coefficient (K_d) values for inorganic constituents are also discussed for metals. For inorganic chemicals, the simple relationship between soil organic carbon content and sorption observed for organic chemicals does not apply; K_d is essentially independent of K_{oc} or K_{ow} .

- Complexation is the ability of metals to form numerous organic and inorganic complexes with inorganic ligands such as carbonate, chloride, hydroxide, and sulfate in the natural environment. Complexation is influenced by many factors, of which pH, and the availability of complexing compounds are significant.
- Precipitation and co-precipitation are important removal mechanisms of dissolved aqueous species. Precipitation depends upon the ionic concentration/aqueous solubility, pH and other physical/chemical considerations of the aqueous media.
- Cationic Exchange – Many metals are capable of undergoing substitution with cations present in the crystal lattice of minerals within soils and sediments. This

process is commonly influenced by the type of clay minerals present in the media and factors such as pH and organic content.

The potential for inorganic constituents to migrate in groundwater is related to their distribution coefficient (K_d). The soil-water distribution coefficient for metals is affected by many geochemical parameters including, but not restricted to, pH, adsorption to clays, oxidation/reduction conditions, ion chemistry of the water, and chemical form of the metal. K_d values for commonly evaluated metals range from less than 1 to over 10,000 mL/g.

Inorganic solutes in groundwater are considered essentially immobile with K_d values exceeding 100 milliliters per gram (mL/g). K_d values between 0.1 and 50 mL/g suggest moderate mobility, and K_d values below 0.1 mL/g suggest high mobility (Dragun, 1988). Trace metals in general tend to be very immobile. Cations are moderately mobile in groundwater, and anions are the most mobile. Because of the number of varying geochemical parameters in the field influencing organic distribution coefficients and differences in experimental methods, a wide range of K_d values are obtained (Table 5-2).

Unlike organic compounds, metals are not degradable through biological or chemical actions and are typically considered to be persistent in the environment. The fate of metals depends primarily on partitioning between soluble and particulate solid phases. Some metals can be oxidized or reduced through the actions of microorganisms that can change their chemical and physical properties. Among the mechanisms discussed in the preceding sections, solubility/aqueous chemical speciation, adsorption/desorption, complexation, precipitation/co-precipitation, and cationic exchange have the potential to significantly influence fate and transport of the metals detected.

Four metals were detected in surface soils above SSSLs and background: arsenic, chromium, iron, and vanadium. The concentrations of six metals in surface soils were above ESVs and background: arsenic, chromium, iron, mercury, vanadium, and zinc. In subsurface soils, four metals (arsenic, iron, thallium, and vanadium) were detected above SSSLs and background.

In groundwater, three metals were detected above SSSLs and background in unfiltered (total metals) samples: aluminum, antimony, and silver. Although antimony and silver exceeded their background values, the detections were both “B” qualified. In the filtered (dissolved) groundwater samples, only antimony, in two samples, exceeded its SSSL and background (Note: a background value for chromium was not available.)

Subsequent to the establishment of background values used in the above screening process, an integrated statistical and geochemical evaluation was performed (Appendix K). Select metals in soils failed statistical comparison to background and were subjected to geochemical evaluation. All of the metals detected in groundwater passed statistical comparison to background and, thus, did not require geochemical evaluation. The study concluded that the metals detected in site media at Range J were all naturally occurring.

5.4 Contaminant Migration

The chemical and physical processes that are involved in the solute transport of contaminants at Range J include advection, dispersion, diffusion, and retardation. The response of these factors to the local hydrogeologic conditions will control the horizontal and vertical migration of VOCs. These processes are briefly discussed in Section 5.4.1. In Section 5.4.2, the horizontal, vertical, and downgradient migration of contaminants is discussed.

5.4.1 Processes Involved in Solute Transport

The mechanisms that govern contaminant transport in the groundwater flow system include various physical and chemical processes. These transport processes include advection, dispersion, diffusion, and retardation, which are briefly discussed below.

5.4.1.1 Advection

Advection is the process of contaminant (solute) migration due to the average linear velocity of groundwater. Advection is typically the most important factor governing solute movement. Contaminants that are moving under advection are travelling at the same rate as the average linear flow velocity of the groundwater. The advective transport term is computed using velocities determined from Darcy's law. The governing chemical parameter in advection is solubility; the effect of advection increases with increasing solubility.

5.4.1.2 Dispersion

Hydrodynamic dispersion is the spread or mixing of contaminants around an average groundwater flow path. Dispersion can occur both longitudinally and transversely. The mixing that occurs along or parallel to the flow path in the horizontal plane is called longitudinal dispersion and that occurring perpendicular to the pathway of fluid flow is called transverse dispersion.

5.4.1.3 Diffusion

Diffusion is the movement of contaminants as a consequence of a concentration gradient. Contaminants diffuse from an area of higher concentration to an area of lower concentration; diffusion will occur until equilibrium in concentration exists. The rate of diffusion increases with temperature and decreases as the porosity of the medium increases. The chemical parameter governing diffusion is the diffusion coefficient; as the diffusion coefficient increases, so does the extent of contamination movement by diffusion.

5.4.1.4 Retardation

Dissolved contaminants moving through an aquifer may interact with solid constituents encountered along its flow path. This interaction may include adsorption, partitioning, ion exchange reactions, and other chemical and physical processes which remove the dissolved constituent(s) from groundwater. The greater the fraction of contaminant sorbed, the more its transport is retarded. Because of these various processes (primarily adsorption), a solute may move at a slower velocity than the groundwater mass itself. One of several accepted and utilized equations for estimating the migration rate of a chemical in a soil-groundwater system is the retardation equation (Fetter, 1988):

$$V_c = V [1 + K_d (D_b/n)]^{-1} = Rd$$

where:

- V_c = Velocity of the chemical at the point where the solute concentration is one-half of the original value
- V = Average linear velocity of groundwater
- K_d = Adsorption coefficient
- D_b = Soil bulk density
- n = Total porosity
- Rd = Retardation factor.

The adsorption or distribution coefficient is a function of the soil's and solute's chemistry and therefore can be compound-specific. For VOCs, the amount of organic carbon present in the aquifer matrix is an important factor. Generally, the larger the value of K_d , the greater the compound's affinity for the solid matrix (Dragun, 1988). For compounds with very low K_d values, the contaminant mass moves at virtually the same rate as the average linear groundwater velocity. The distribution coefficient is defined by:

$$K_d = C_s / C_w = f_{oc} \bullet K_{oc}$$

where:

- C_s = Concentration by weight in soil
- C_w = Concentration by volume in water
- f_{oc} = Fraction of organic carbon
- K_{oc} = Organic partitioning coefficient.

5.4.2 Migration of Contaminants

Based on the soil and groundwater data collected at the site, the most significant fate and transport pathway is the leaching of organic contaminants within subsurface soils and movement through the residuum and into the bedrock groundwater system. The general absence of VOCs in surface and subsurface soils suggests that significant removal and/or subsequent leaching of organic contaminants to groundwater has occurred. Other than one detection of acetone in a surface soil sample, only reduced concentrations below SSSLs and ESVs remain.

The mobility of inorganic constituents is primarily related to their retardation factor (Table 5-2). Depending upon how the metals enter site media, some may persist near the source area longer than others. For example, some metals may enter shallow aquifers in a reduced state. It would be expected that these metals would migrate in the groundwater until pH and Eh conditions were such that precipitation might occur. If dissolved metals entered the bedrock, they would likely migrate significant distances through fractures or solution-enhanced pathways. This migration would be relatively unhindered, due to a chemically more reducing environment and a lower percentage of naturally present organic matter.

Vertical hydraulic gradients were calculated for seven well clusters in the area of groundwater contamination and are presented in Table 3-2. The calculated gradients in general were relatively low and positive, indicating a weak and prevalent downward flow. Of the seven well clusters, only one had a negative or upward gradient.

Isopleth maps were constructed for total VOCs, chlorinated solvents, and carbon tetrachloride concentrations and are shown on Figures 4-6 through 4-14. Plume maps of the constituents show a general westward migration of the area of maximum concentration, with a southern and eastward overall spreading with depth in the residuum and transitional zones. In the bedrock interval, contamination follows a west-northwest path. However, none of the maps defining the plumes demonstrates a clear relationship of contaminant plume migration to groundwater flow direction. This apparent anomaly may be the result of the very low potentiometric head

difference across the site. Under these conditions, the effect of advective transport, typically the most important factor governing solute movement, may be reduced. Transport mechanisms such as dispersion and diffusion would play a more significant role in contaminant migration than otherwise anticipated. This would be especially true for the residuum. In the bedrock, fracture or solution porosity pathways may provide the dominant mechanism for flow movement. Additionally, factors controlling retardation would become more important.

Vertical hydraulic gradient values support that downward flow of groundwater seasonally dominates. Specific gravity values are presented in Table 5-1 for the VOCs that exceeded SSSLs in groundwater. If present as a free-phase product, or at concentrations approaching the contaminant's solubility limit, these compounds might be expected to sink within the aquifer. However, the concentrations of dissolved VOCs presently detected are too low for density to be a factor in vertical migration.

Figures 5-1 through 5-6 are geologic cross sections that graphically demonstrate the vertical and horizontal transport and migration of total VOCs (Figures 5-1 and 5-2), chlorinated VOCs (Figures 5-3 and 5-4), and carbon tetrachloride (Figures 5-5 and 5-6) at the site. The geologic cross sections were constructed using well data and analytical data previously presented in this report. They represent the net effect of all the various chemical and physical parameters discussed.

Table 5-3 summarizes the groundwater velocity data for the residuum, transitional, and bedrock intervals at the site. The linear or advective groundwater flow velocity calculated for each of the three zones is anomalously low. Velocity calculations range from 0.01345 ft/day in the transitional zone (Zone B), to 0.01581 ft/day in the residuum (Zone A), to 0.10562 ft/day in the bedrock (Zone C). These velocities are considered to be too low to adequately account for the contaminant distribution at the site to be the result of advective flow alone. It is speculated that the extremely low horizontal hydraulic gradient encountered at the site is the major factor resulting in the low velocities calculated. Hydraulic conductivities derived from the slug test data appear valid. Assumptions for bulk density, porosity, and percent total organic carbon of the aquifer material are within ranges commonly specified in the literature for the residuum.

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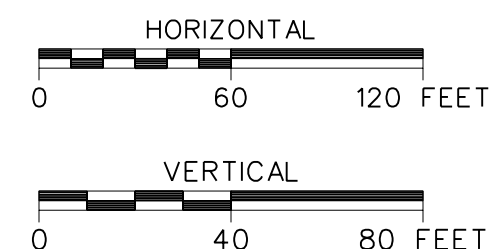
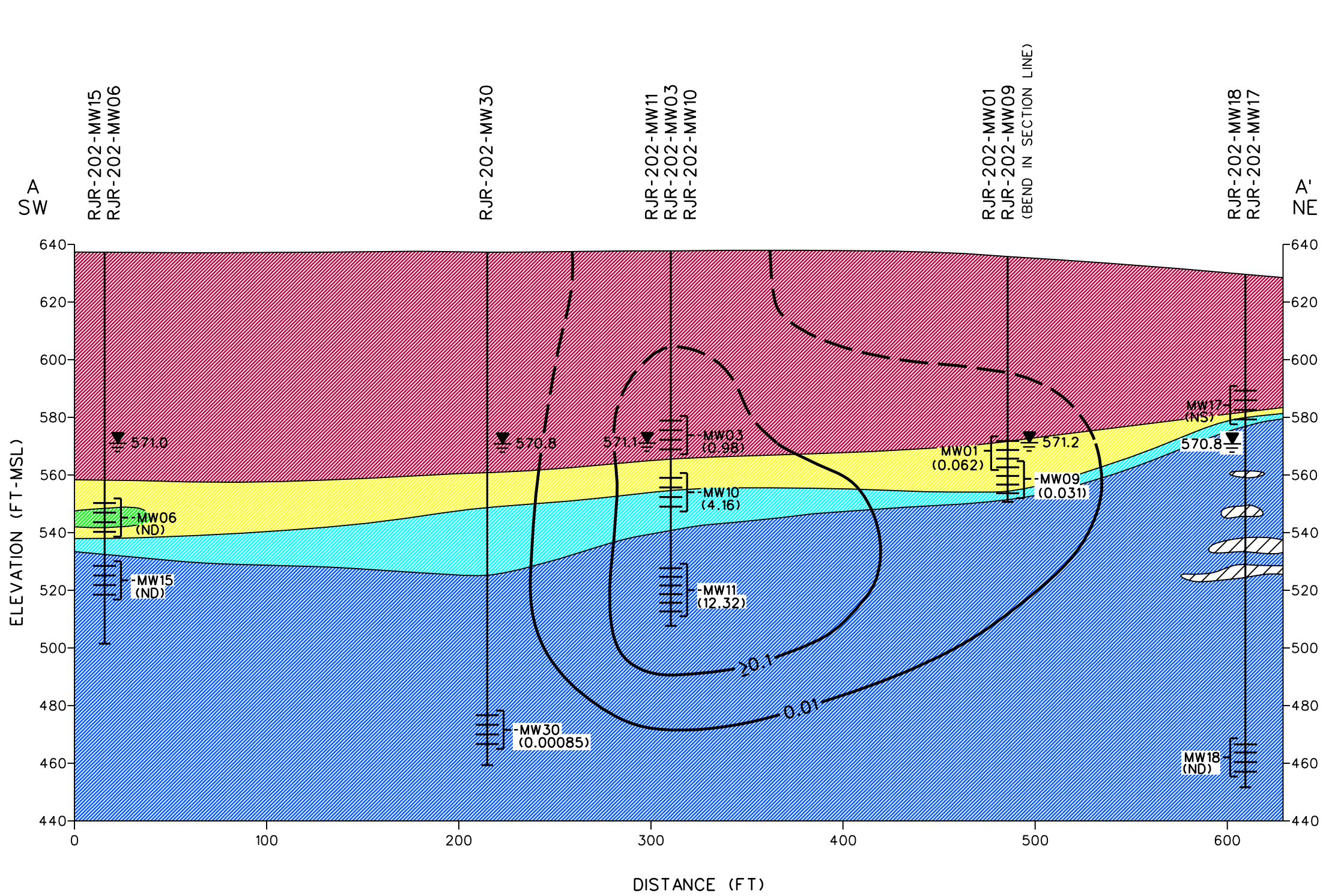
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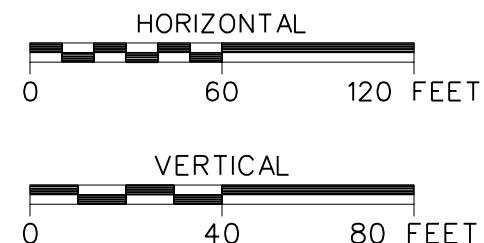
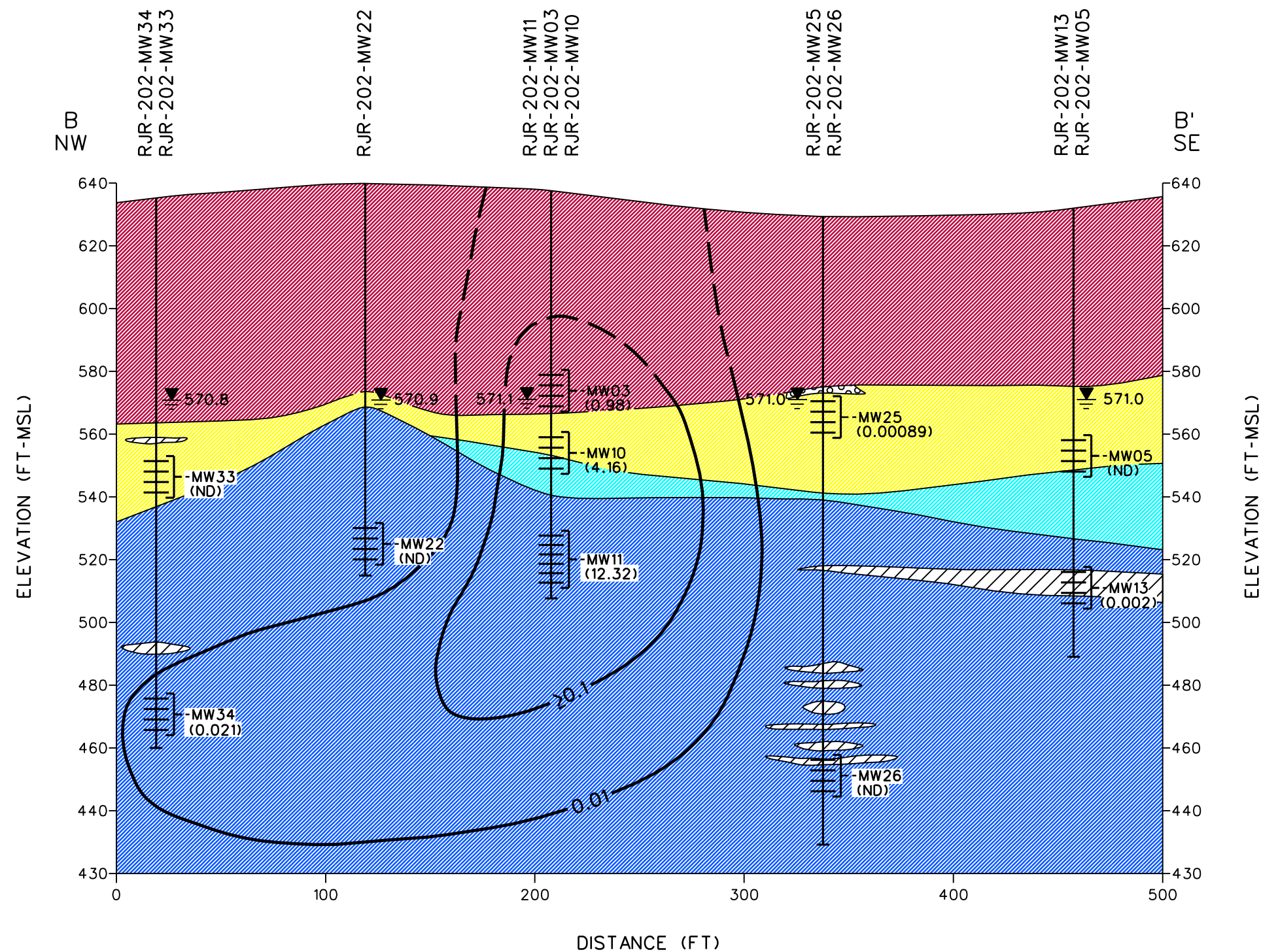


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MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

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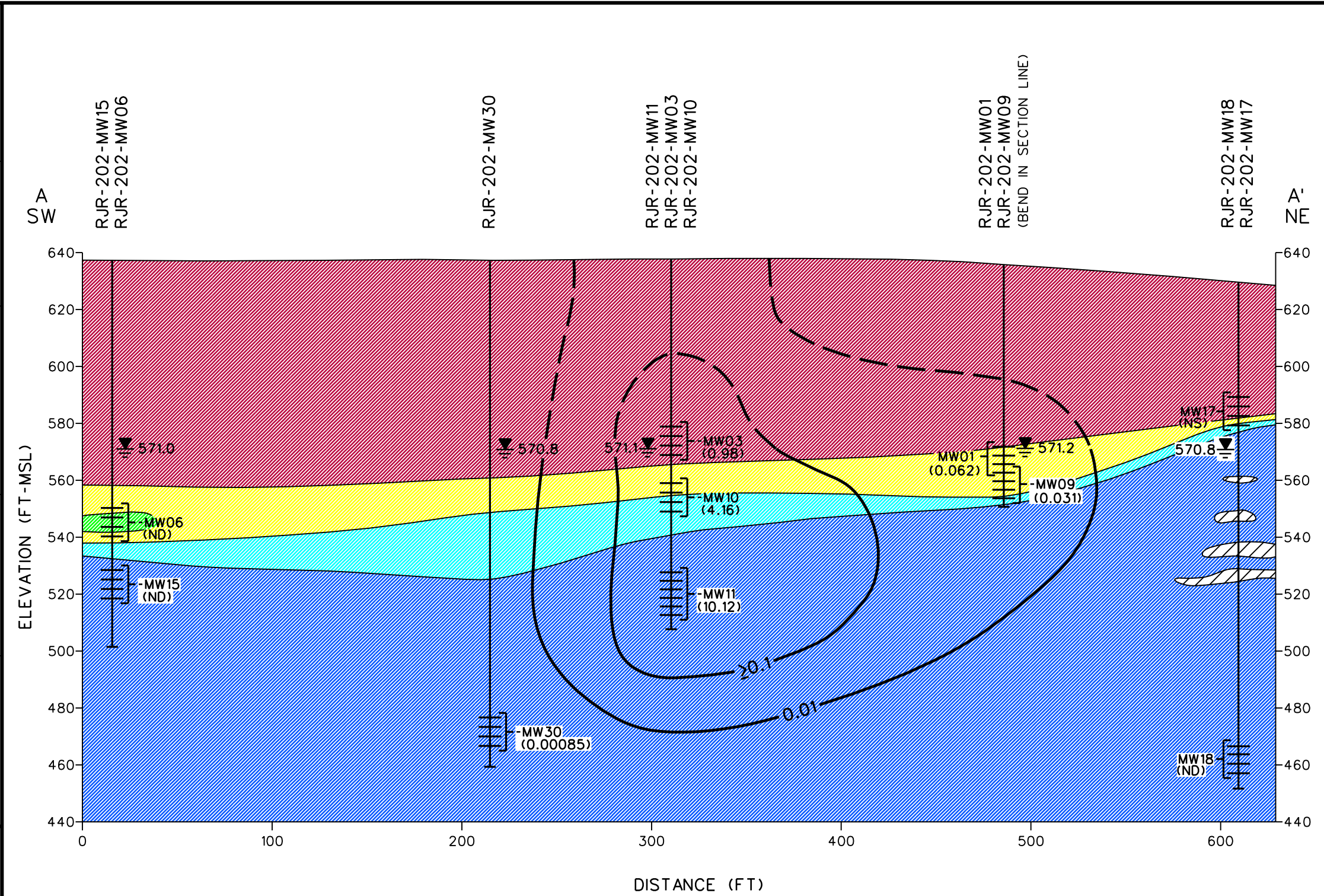
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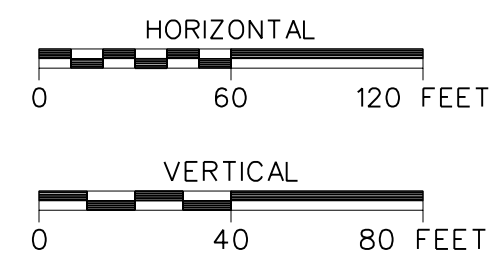


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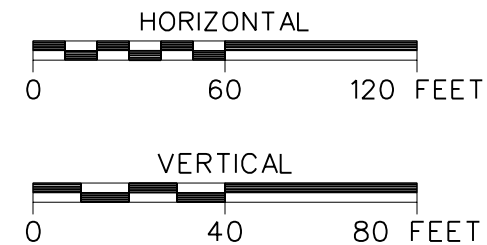
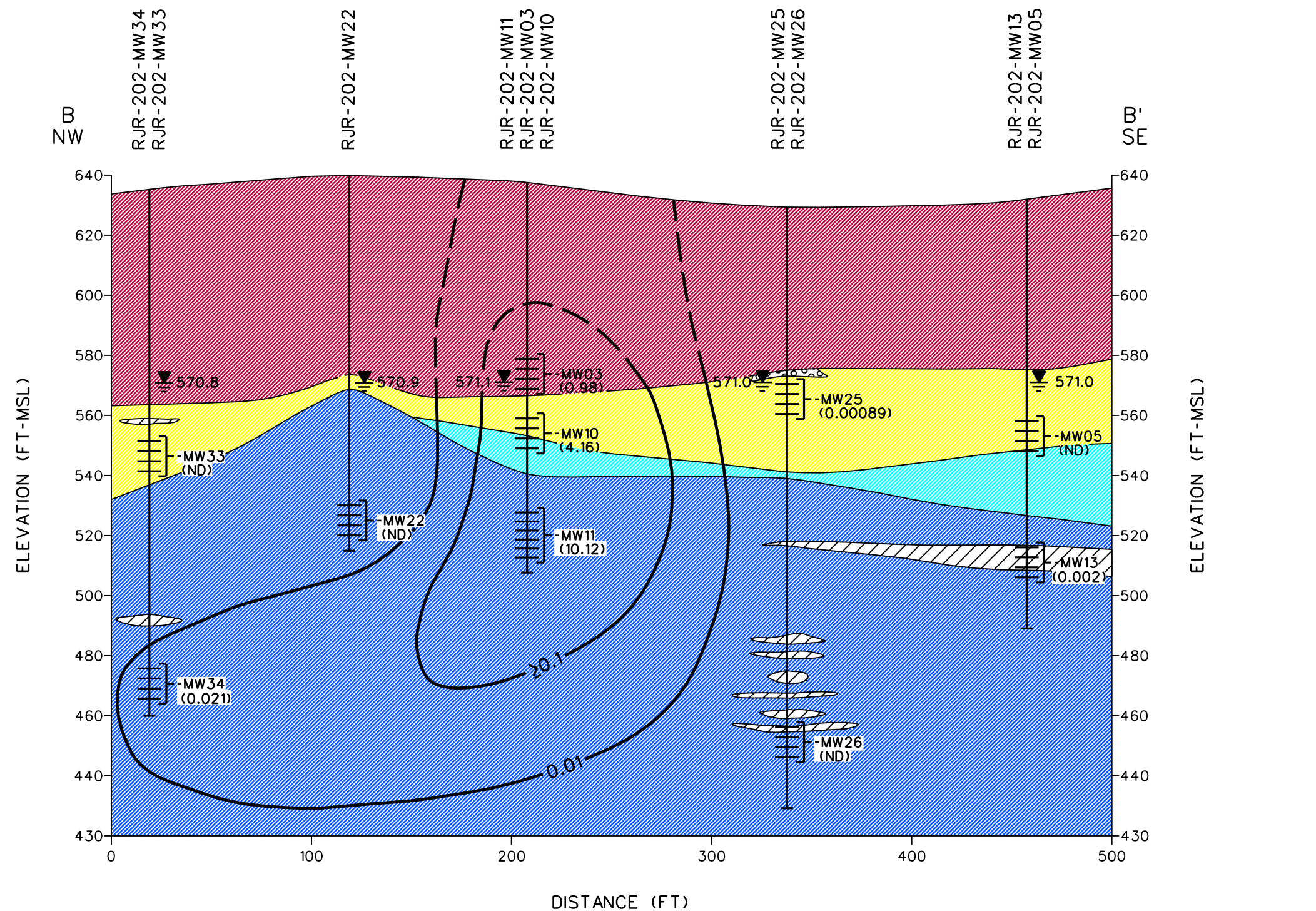
- SCREEN INTERVAL
- WATER TABLE
- 570.8 GROUNDWATER ELEVATION (FT MSL) (OCTOBER 2, 2001)
- VOIDS
- CHLORINATED VOC CONCENTRATION IN GROUNDWATER (mg/L)
- ND NOT DETECTED
- NS NOT SAMPLED
- (0.031) CONCENTRATION IN MILLIGRAMS PER LITER (mg/L)
- SAND
- CLAY
- SILT AND CLAY
- WEATHERED DOLOMITE
- DOLOMITE

- NOTES:**
1. CHLORINATED VOCs CALCULATED EXCLUDING COMMON LABORATORY CONTAMINANT METHYLENE CHLORIDE.
 2. GROUNDWATER ELEVATIONS ARE AVERAGED BETWEEN ADJACENT WELLS. SEE TABLE 2-5 FOR INDIVIDUAL ELEVATIONS.

FIGURE 5-3
GEOLOGIC CROSS SECTION A-A'
CHLORINATED VOCs
RANGE J - PELHAM RANGE
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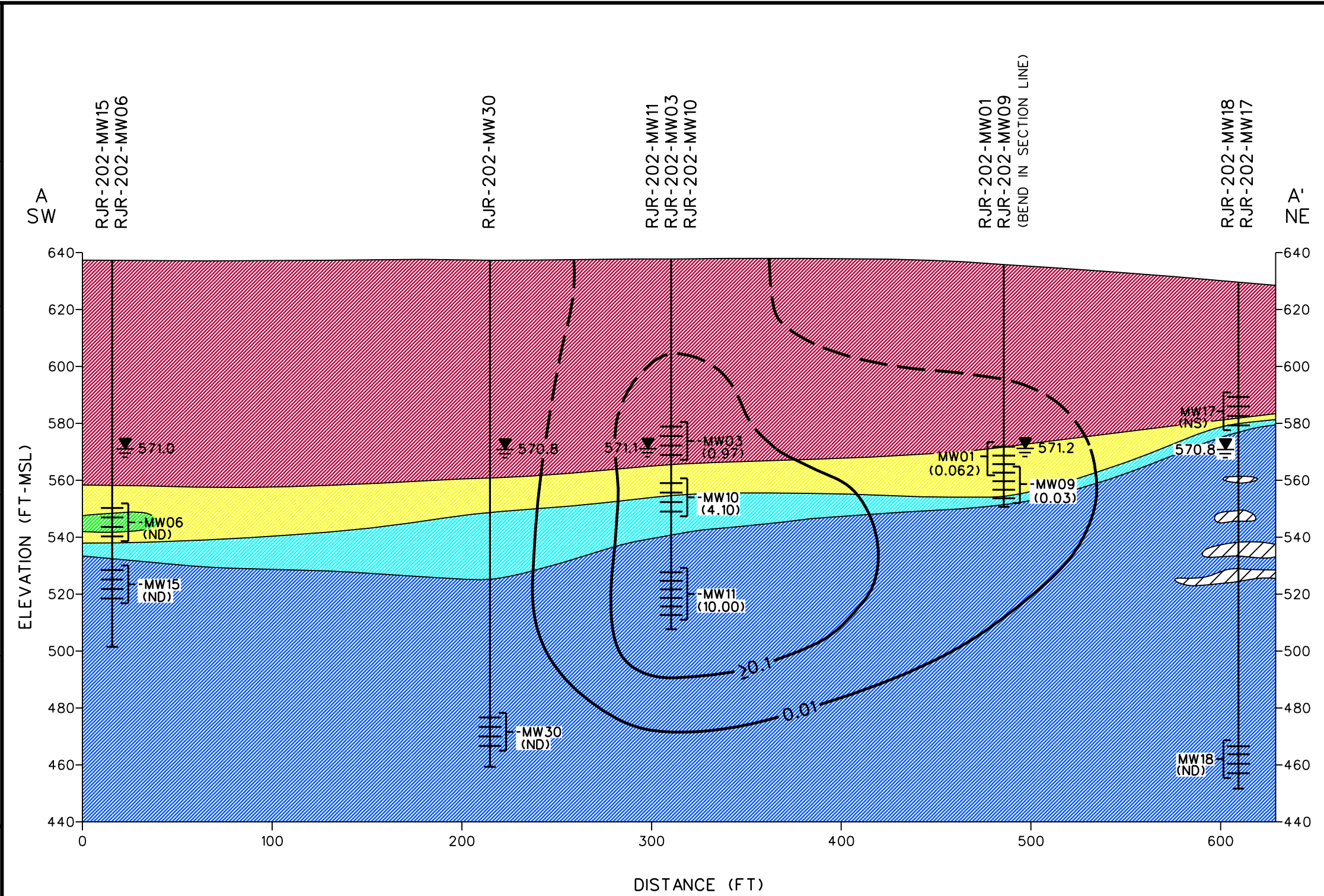
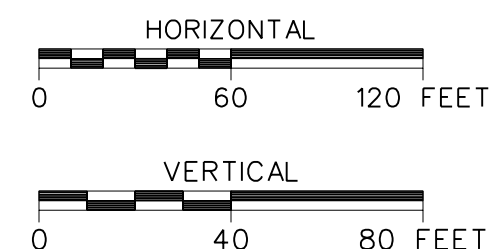
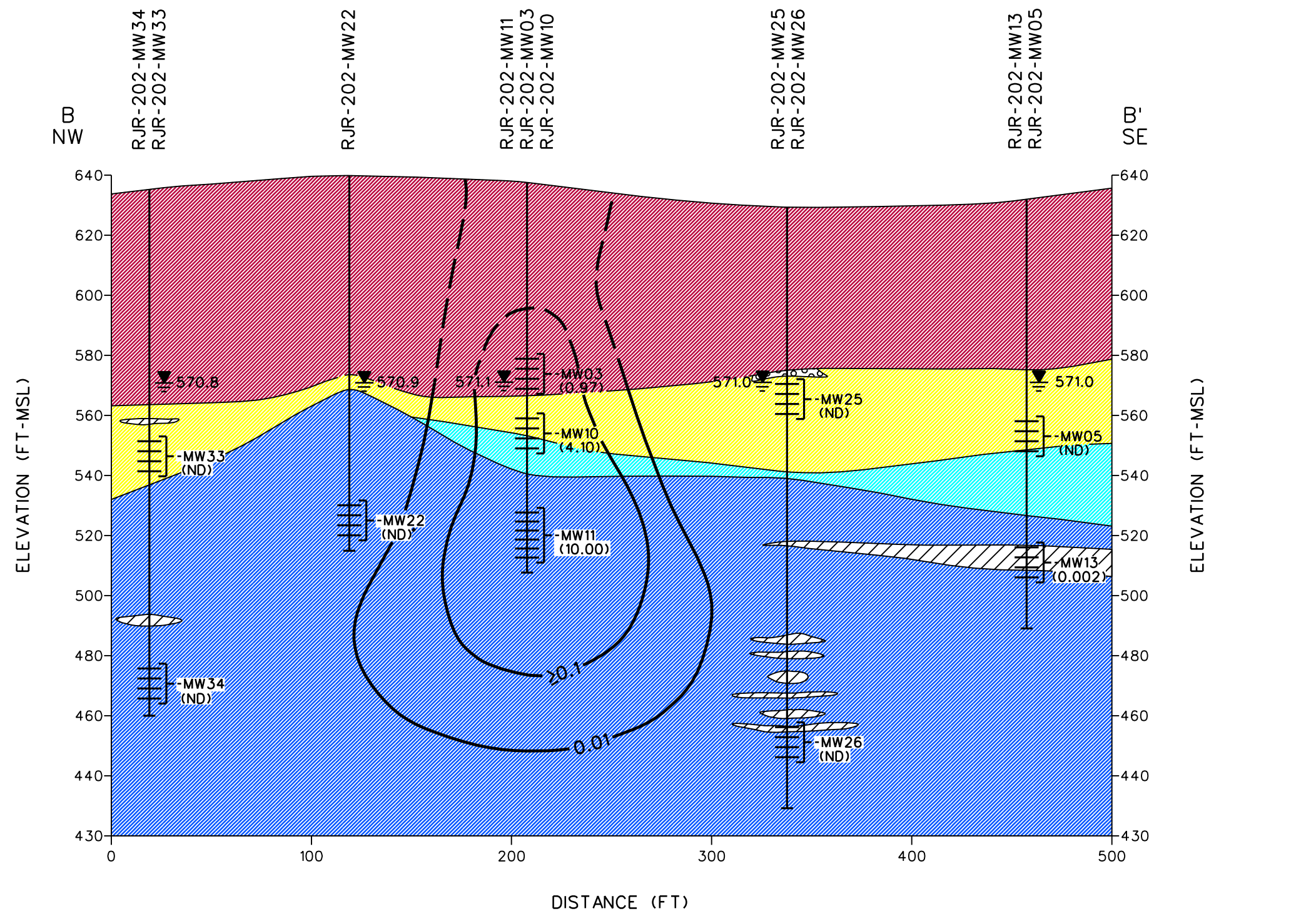


FIGURE 5-5
GEOLOGIC CROSS SECTION A-A'
CARBON TETRACHLORIDE
RANGE J - PELHAM RANGE
PARCEL 202(7)

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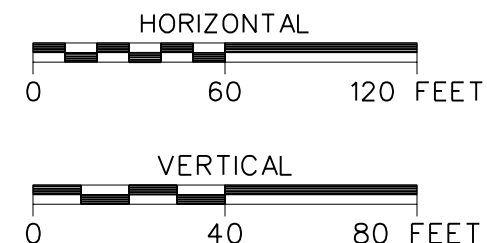
LEGEND

- SCREEN INTERVAL
- WATER TABLE
- 570.8 GROUNDWATER ELEVATION (FT MSL) (OCTOBER 2, 2001)
- VOIDS
- CARBON TETRACHLORIDE CONCENTRATION IN GROUNDWATER (mg/L)
- ND NOT DETECTED
- (4.10) CONCENTRATION IN MILLIGRAMS PER LITER (mg/L)
- GRAVEL
- SAND
- SILT AND CLAY
- WEATHERED DOLOMITE
- DOLOMITE

NOTE:

1. GROUNDWATER ELEVATIONS ARE AVERAGED BETWEEN ADJACENT WELLS. SEE TABLE 2-5 FOR INDIVIDUAL ELEVATIONS.

FIGURE 5-6
GEOLOGIC CROSS SECTION B-B'
CARBON TETRACHLORIDE
RANGE J - PELHAM RANGE
PARCEL 202(7)



U. S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT
FORT McCLELLAN
CALHOUN COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

6.0 Streamlined Human Health Risk Assessment

6.1 Introduction

Due to the large size and complexity of the FTMC installation, a streamlined human health risk assessment (SRA) is developed using SSSLs. The SSSLs are medium-specific and receptor-specific, risk-based screening concentrations that are used to quickly and efficiently screen the site for potential cancer risk and noncancer hazards from residual chemicals in environmental media. The SSSLs address all significant exposure pathways and are sufficiently site-specific with regard to exposure assumptions that they are used to estimate risk with as much precision as a typical baseline risk assessment. The exposure assumptions and SSSL methodology are described in detail in the installation-wide work plan (IT, 2002a). The SSSLs were recently updated with the most current toxicity values and are compiled in the *Human Health and Ecological Screening Values and PAH Background Summary Report* (IT, 2000c) that also presents toxicity profiles, which are brief descriptions of the physical and toxicological properties of the chemicals that may be identified as contaminants at FTMC sites.

The methodology behind the SSSLs and the chemical-specific variable values used in the SSSL calculations are presented in the *Final Human Health and Ecological Screening Values and PAH Background Summary Report* (IT, 2000c). Information pertinent to the development of the National Guardsperson SSSLs is presented in an IT memorandum (IT, 2001b).

6.2 Streamlined Risk Assessment Protocol

An SRA consists of the following steps, which are discussed in the following sections.

- Develop a conceptual site exposure model (CSEM)
- Select site-related chemicals
- Select chemicals of potential concern (COPC)
- Characterize risk
- Identify chemicals of concern (COC)
- Develop remedial goal options (RGO).

6.2.1 Develop a Conceptual Site Exposure Model

The CSEM identifies the potentially contaminated environmental media, contaminant migration pathways, exposure media, plausible receptors, and exposure routes. Three receptor scenarios are evaluated for Range J: the recreational site user (with hunting), the National Guardsperson, and the resident. These receptor scenarios were selected based on the information provided in the *Fort McClellan Comprehensive Reuse Plan, Implementation Strategy* (EDAW, 1997)

regarding the proposed future land use for Range J. The residential scenario, generally considered the most conservative of all exposure scenarios, is included to provide additional information to risk managers. The CSEM for Range J is shown on Figure L-1 in Appendix L.

6.2.2 Select Site-Related Chemicals

Generally, chemicals are excluded from the SRA if they are essential nutrients, if they occur at such a low detection frequency and concentration that they are considered to be artifacts of sampling or laboratory analysis, or if they are present at concentrations comparable to background. Comparisons with background are limited to metals, because data usually are not sufficient to quantify anthropogenic background levels of organic chemicals. An integrated statistical and geochemical approach (Shaw, 2003) was used to determine whether the metals in soil and groundwater are present at background concentrations or if they represented site-related chemicals (Appendix K). Site-related chemicals are carried to the next step of the SRA.

6.2.3 Select Chemicals of Potential Concern

COPCs are the chemicals that may contribute significantly to risk. They are selected by comparing the maximum detected concentrations (MDC) of site-related chemicals to their respective SSSLs. Since the SSSLs are receptor-specific, COPCs are also receptor-specific. In other words, a chemical may be selected as a COPC for residential exposure but not for recreational site use. This occurs because the SSSL for residential exposure is lower than that for recreational site use, because the resident is more highly exposed. Source-term concentrations (STC) are estimated for the COPCs. An STC is a conservative estimate of the concentration of a COPC averaged over the entire site. The STC is mathematically equivalent to the exposure-point concentration and is used to quantify the receptor's exposure to the COPCs. More information regarding the development and use of STCs and exposure-point concentrations is presented in the installation-wide work plan (IT, 2002a). COPCs are carried to the risk characterization step of the SRA.

6.2.4 Characterize Risk

The appropriate SSSL is compared to the STC to estimate an incremental lifetime cancer risk (ILCR) or hazard index (HI) for each COPC in each environmental medium, as explained in the installation-wide work plan (IT, 2002a). The ILCRs and HIs are summed across all exposure routes and all COPCs to yield a total ILCR and total HI for a given receptor exposed to a given medium. The total ILCRs and HIs for all media are summed to yield a total ILCR and a total HI for a given receptor exposed to all media. Total ILCR estimates for a receptor that are less than 1E-6 are considered to be negligible (EPA, 1990). ILCR estimates between 1E-6 and 1E-4 are

considered to fall within a risk management range. ILCR estimates that exceed $1\text{E-}4$ are considered to be unacceptable and trigger estimation of remedial goal options (RGO). HI estimates for a receptor above a threshold level of 1 raise concern for the occurrence of adverse noncancer effects (EPA, 1989). However, summing HI values for all chemicals may overstate the potential for adverse effects. EPA (1989) believes that the assumption of additivity is valid only for chemicals that operate by the same mechanism of toxicity; therefore, the HI values may be segregated on the basis of mechanism of toxicity. Data concerning mechanisms of toxicity are available for very few chemicals; therefore, critical effect or the target organ for exposure near the threshold is used as a surrogate, assuming that chemicals that act on the same target organ may operate by the same mechanism of toxicity.

Metals that are not selected as site-related chemicals in surface soil (Table L-2), groundwater (Table L-5), and total soil (Table L-14) because they are assumed to be present at concentrations comparable to background (i.e., “background” chemicals) are not included in the quantitative risk estimates described in the previous paragraph. Instead, they are discussed qualitatively. Background chemicals whose concentrations fall below their respective SSSLs are interpreted as posing no threat to human health. Background chemicals whose concentrations exceed their SSSLs are interpreted as possibly posing a threat to human health. The interpretation of risk associated with background chemicals and the uncertainty about their designation as background chemicals are discussed below.

6.2.5 Identify Chemicals of Concern

COCs are chemicals that contribute significantly to ILCR or HI for a receptor scenario with unacceptable risk levels, i.e., a total ILCR summed across all COPCs and media greater than $1\text{E-}4$ or a total HI greater than 1 (after segregation by target organ).

6.2.6 Develop Remedial Goal Options

RGOs are risk-specific concentrations developed for chemicals identified as COCs (EPA, 2001). The cancer-based SSSLs are adopted as RGOs based on an ILCR of $1\text{E-}6$; RGOs are also developed for cancer risks of $1\text{E-}5$ and $1\text{E-}4$. The noncancer-based SSSLs are adopted as RGOs based on an HI of 0.1; RGOs are also developed for HI values of 1 and 3.

6.3 Results

Surface soil, total soil, and groundwater are the media evaluated for Range J. The receptor scenarios determined to be applicable to Range J include the recreational site user, National

Guardsperson, and the resident. Tables and figures for the Range J SRA are included in Appendix L, and risks are summarized by receptor and medium in the following table:

Source Medium	Recreational Site User		National Guardsperson		Resident	
	ILCR	HI	ILCR	HI	ILCR	HI
Surface Soil	-- ^a	-- ^a	--	--	--	--
Total Soil	NA	NA	--	--	--	--
Groundwater	NA	NA	8.54E-4	3.68E+1	6.14E-3	2.48E+2
Total ILCR/Hi ^b	NS	NS	8.54E-4	3.68E+1	6.14E-3	2.48E+2

ILCR = incremental lifetime cancer risk.

HI = noncancer hazard index.

NA = not applicable; receptor not exposed to this medium.

NS = no summation because risks were not estimated for applicable media.

--^a ILCR and HI not estimated because no chemicals of potential concern were selected in this medium for this receptor.

^b Summed across all applicable media.

6.3.1 Surface Soil

Forty-eight surface soil samples, including 16 samples re-collected and analyzed for CWM breakdown products only, were evaluated in the SRA (Table L-1, Appendix L). The surface soil samples were collected largely from the 0 to 1 foot depth interval, with 5 samples collected from 0 to 2 feet deep. Twenty-four of these samples were analyzed for CWM breakdown products (including orthosulfur compounds), SVOCs, and VOCs. Eight of the first batch of 32 samples were analyzed for metals and VOCs. CWM breakdown products are residues of sulfur mustard gas and organophosphate nerve gasses. No CWM breakdown products were detected in the surface soil samples analyzed for these constituents (Table L-2).

The site-to-background comparison indicated that all metals in surface soil were statistically within range of background or were present at naturally occurring concentrations; therefore, no metals were selected as site-related chemicals (Table L-2). The protocol and the results of the site-to-background comparison, including the justification for the preceding statement, are presented in Appendix K. One SVOC, bis(2-ethylhexyl)phthalate, and eight VOCs were determined to be site-related chemicals. Several VOCs reported infrequently at concentrations near or below the reporting limit were judged not to be site-related. These VOCs are not associated with CWM or solvents that might be used in decontamination processes. Furthermore, none of them were identified in groundwater.

Table L-3 presents the comparison of the surface soil site-related chemicals to the receptor-specific surface soil SSSLs. The recreational site user and the venison consumer were the receptor scenarios evaluated for exposure to surface soil. The on-site resident and National

Guardsperson are also exposed to surface soil, but these receptors are evaluated for exposure to both surface and subsurface soil, as explained in Section 6.3.3. None of the site-related chemicals had an MDC greater than its respective soil SSSL; therefore, no surface soil chemicals were selected as COPCs.

As noted above, all metals in surface soil were determined to be present at concentrations comparable to background. The MDCs of the background metals were compared with recreational site user SSSLs for soil as an indication of the potential threat to human health posed by background conditions. No metal MDCs exceeded their respective SSSLs (data not shown). It is concluded that background metals in surface soil pose no unacceptable health threat to plausible receptors exposed to surface soil alone.

6.3.2 Groundwater

Forty-six groundwater samples, collected from 30 monitoring wells in 1999 and 2001, were evaluated in the SRA (Table L-4). Thirty groundwater samples were analyzed for metals and VOCs, and 16 samples were analyzed for CWM breakdown products, SVOCs, and VOCs. The National Guardsperson and the resident were evaluated for their potential future exposure to groundwater.

Sixteen metals, 2 SVOCs, and 19 VOCs were detected in groundwater at the site (Table L-5). After the background and essential nutrient evaluations, only 2 SVOCs and 8 VOCs were determined to be site-related. Several organic compounds were determined not to be site-related because they had very low detection frequencies at very low concentrations.

Table L-6 presents the COPC selection for the resident exposed to groundwater. Seven VOCs (1,1,2,2-PCA, 1,2-DCA, benzene, carbon tetrachloride, chloroform, PCE, and TCE) were selected as COPCs for the resident. 1,1,2,2-PCA was selected on the basis of cancer risk alone; the other COPCs for the resident were selected for both cancer risk and noncancer hazard. 1,2-DCA, benzene, carbon tetrachloride, chloroform, and PCE were selected as COPCs for the National Guardsperson. 1,2-DCA and PCE were selected on the basis of cancer risk alone; the other COPCs for the National Guardsperson were selected for both cancer risk and noncancer hazard.

Table L-7 presents the cancer risk and noncancer hazard estimates for the resident exposed to COPCs in groundwater. The resulting HI for the resident exposed to COPCs in groundwater is 248, which exceeds the threshold of 1. The resulting ILCR for the resident exposed to COPCs in

groundwater is $6.1\text{E-}3$, which exceeds the upper end of the risk management range and is considered unacceptable. Therefore, based upon these analytical data, groundwater at Range J presents an unacceptable cancer risk and noncancer hazard to a future resident. The main cancer risk and noncancer hazard driver for groundwater at Range J is carbon tetrachloride ($\text{HI} = 221$, $\text{ILCR} = 5.7\text{E-}3$), although benzene contributes significantly to the unacceptable ILCR and benzene and chloroform also add significant HI values.

Table L-8 presents the groundwater cancer-based RGOs for the resident. All cancer-based COPCs with an ILCR greater than $1\text{E-}6$ for the resident were selected as COCs; these include 1,1,2,2-PCA, 1,2-DCA, benzene, carbon tetrachloride, chloroform, and PCE. It should be noted that the STCs of 1,2-DCA, benzene, and carbon tetrachloride exceed their respective maximum contaminant levels (MCL) (EPA, 2000); the STCs of 1,1,2,2-PCA, chloroform and PCE fall below their MCLs.

Table L-9 presents the groundwater noncancer-based RGOs for the resident. All noncancer-based COPCs with an HI greater than 0.1 for the resident were selected as COCs; these include 1,2-DCA, benzene, carbon tetrachloride, and chloroform.

Table L-10 presents the cancer risk and noncancer hazard estimates for the National Guardsperson exposed to COPCs in groundwater. The resulting HI for the National Guardsperson exposed to COPCs in groundwater is 37, which is above the threshold of 1. The resulting ILCR for the National Guardsperson exposed to COPCs in groundwater is $8.5\text{E-}4$, which exceeds the risk management range and is considered unacceptable. Therefore, based upon these analytical data, groundwater at Range J presents an unacceptable cancer risk and a noncancer hazard to a future National Guardsperson. As with the resident, the main cancer risk and noncancer hazard driver for groundwater at Range J is carbon tetrachloride ($\text{HI} = 33$, $\text{ILCR} = 7.9\text{E-}4$).

Table L-11 presents the groundwater cancer-based RGOs for the National Guardsperson. All cancer-based COPCs with an ILCR greater than $1\text{E-}6$ were selected as COCs; these include 1,2-DCA, benzene, carbon tetrachloride, and chloroform.

Table L-12 presents the groundwater noncancer-based RGOs for the National Guardsperson. All noncancer-based COPCs with an HI greater than 0.1 were selected as COCs; these include benzene, carbon tetrachloride, and chloroform.

As shown in Table L-5, all metals in groundwater were determined to be present at concentrations comparable to background. The MDCs of the background metals were compared with residential SSSLs for groundwater as an indication of the potential threat to human health posed by background conditions. Metal MDCs exceeded their respective SSSLs for aluminum, arsenic, barium, chromium, iron, and manganese (data not shown). The SSSLs for all but arsenic, however, are based on noncancer effects. Had these metals been selected as site-related COPCs, their HI values would have ranged from 1.1E-1 to 4.3E-1 (data not shown), below the threshold level of 1, indicating low potential for adverse health effects. The SSSL for arsenic is based on cancer risk. Had arsenic been selected as a site-related COPC, an ILCR of 9.06E-5 would have been estimated from the MDC of 4.04E-3 mg/L. The ILCR of 9.06E-5 falls within the risk management range; however, arsenic would be a significant contributor to the unacceptable ILCR calculated for the site-related VOCs.

6.3.3 Total Soil

Ninety-six total soil samples, including 32 samples re-collected and analyzed for CWM breakdown products only, were evaluated in the SRA (Table L-13). 'Total soil' is a term used to acknowledge the fact that a human receptor cannot be exposed to subsurface soil without being exposed to surface soil. In other words, any kind of development for future use requiring excavation or grading will result in a mixture of surface and subsurface soil left at the surface, designated total soil, which receptors may contact. The total soil data set is created by combining the data sets for surface and subsurface soil up to a total depth of 12 feet. It is assumed that no construction work would occur at a depth greater than 12 feet; thus, there would be no human exposure to soil below 12 feet.

Soil sample analyses included metals, VOCs, SVOCs, and CWM breakdown products (including orthosulfur compounds). The resident and National Guardsperson were evaluated for exposure to total soil.

Nineteen metals, one SVOC, and 15 VOCs were detected in total soil at the site (Table L-14). The background analysis (Appendix K) showed that all metals in total soil were present at concentrations comparable to background; therefore, no metals were selected as site-related compounds. One SVOC, bis(2-ethylhexyl)phthalate, and 7 VOCs were determined to be site-related chemicals. Several VOCs were determined not to be site-related due to their low detection frequency (less than 5 percent) at low concentrations; thus, they were not carried forward to the SSSL screening step for COPC selection.

Table L-15 presents the comparison of the total soil site-related chemicals to the receptor-specific surface soil SSSLs. The resident and National Guardsperson were the receptor scenarios evaluated for exposure to total soil. None of the site-related chemicals had an MDC greater than its respective soil SSSL; therefore, no total soil chemicals were selected as COPCs.

As noted above, all metals in total soil were determined to be present at concentrations comparable to background. The MDCs of the background metals were compared with residential SSSLs for soil as an indication of the potential threat to human health posed by background conditions. Metal MDCs exceeded their respective SSSLs for aluminum, arsenic, chromium, iron, manganese, and vanadium (data not shown). The SSSLs for all but arsenic, however, are based on noncancer effects. Had these metals been selected as site-related COPCs, their HI values would have ranged from $1.5\text{E-}1$ to $2.2\text{E-}1$ (data not shown), below the threshold level of 1, indicating low potential for adverse health effects. The exception is iron, for which an HI of 2.7 would have been estimated. The toxicity evaluation for iron, however, is controversial because it almost certainly overestimates the potential for adverse effects, particularly for exposure in soil, and hazard is not usually quantified (see toxicity profile for iron in IT [2000c]).

The SSSL for arsenic is based on cancer risk. Had arsenic been selected as a site-related COPC, an ILCR of $9.18\text{E-}5$ would have been estimated from the STC of $3.91\text{E+}1$ mg/kg. The ILCR of $9.18\text{E-}5$ falls within the risk management range; however, arsenic in total soil would be a significant contributor to the unacceptable ILCR calculated for the site-related VOCs in groundwater.

6.3.4 Future Groundwater Conditions

The potential for chemicals to leach from soil to groundwater was evaluated for Range J. The COPCs selected in groundwater for residential exposure were identified as the chemicals most likely to be of concern for leaching. The MDCs of these chemicals in total soil were compared with the EPA (1996) soil-screening levels based on a dilution-attenuation factor of 20. If the soil MDC was above background and the EPA soil-screening level, then that chemical was evaluated for its future potential to leach to groundwater. Table L-16 presents the selection of chemicals for future groundwater evaluation. Acetone was the only chemical to be selected based upon its potential to leach from soil to groundwater.

Table L-17 presents the future groundwater model for acetone. Using EPA (1996) default physical parameters and chemical-specific parameters (see toxicity profile for acetone in IT [2000c]), a future potential concentration of acetone of $1.47\text{E+}1$ mg/L in groundwater was

estimated, which is equivalent to an HI of 9.41 for the resident. This exceeds the accepted threshold of 1. However, due to the large uncertainty regarding the acetone concentration in soil, no RGOs are developed for acetone in soil. Acetone in soil is discussed further in the uncertainty section (Section 6.3.5).

6.3.5 Uncertainty Analysis

Probably the most significant source of uncertainty in the SRA is the widespread occurrence of acetone in soil samples. Acetone was detected in all 20 surface soil samples evaluated, 15 of 19 subsurface soil samples evaluated, and 3 of 23 groundwater samples evaluated. One acetone detection in surface soil, 21 mg/kg, is clearly driving the HI for acetone associated with the future groundwater evaluation. It would be more reasonable to use the upper confidence limit of 3.05 mg/kg, rather than the MDC of 21 mg/kg, in the future groundwater model. The HI estimated for exposure to future groundwater using the upper confidence limit would be 1.36 (data not shown), which, when rounded to one significant figure to reflect the uncertainty about the estimation, is equivalent to the threshold limit of 1.

The source of acetone at Range J is unclear. However, it is likely that the acetone is an artifact from the use of isopropyl alcohol as a solvent in equipment decontamination during the process of taking samples of environmental media for this investigation. Associated quality assurance equipment rinsate blank sample data also show acetone at trace level concentrations, which may indicate that the sampling equipment was contributing to the acetone concentrations in the field samples. Because the equipment rinsate blanks were collected once per week and the individual field samples were collected daily, their correlation is not exact, but the relationship is implied. Isopropyl alcohol is known to degrade to acetone under oxidative conditions (Hazardous Substance Data Bank, 2003), which may explain the presence of acetone in the rinsate samples. Nonetheless, the soil sampling equipment rinsate blank for the week when the sample with the highest acetone concentration was collected had no detectable concentration of acetone. Therefore, the high acetone detection in surface soil cannot be totally discounted, and it was carried through the SRA. The decontamination procedures have since been changed; only deionized water is used for rinsing the equipment now. This should reduce uncertainty regarding sampling equipment in the future.

Another source of uncertainty involves the potential for background metals – those excluded from the quantitative assessment – to contribute significantly to site-related risk had their designation as background chemicals been erroneous. All metals in surface soil, groundwater, and total soil were determined to be background chemicals and were excluded from the

quantitative assessment. The MDCs of all background metals in surface soil, however, were below their SSSLs (Section 6.3.1). Therefore, it is concluded that the background metals in surface soil, had their designation as background chemicals been erroneous, are very unlikely to contribute significantly to site-related risk.

Some of the background metal concentrations in groundwater exceeded their SSSLs, but these metals are unlikely to contribute significantly to site-related risk should their designation as background be in error, because their HI values would fall below the threshold level of 1. The possible exception is arsenic, which would have an ILCR at the high end of the risk management range. The MDC of arsenic, however, is below the background screening criterion (Appendix K), which is generally considered the most conservative estimator for designating a metal as a background chemical. Therefore, it is considered unlikely that groundwater chemicals erroneously designated as background would contribute significantly to site-related risk.

Some of the background metal concentrations in total soil exceeded their SSSLs, but these metals are unlikely to contribute significantly to site-related risk should their designation as background be in error, because their HI values would fall below the threshold level of 1. The possible exception is arsenic, which would have an ILCR at the high end of the risk management range. Arsenic was designated a background chemical on the basis of geochemical analysis, since statistical analysis could not rule out its presence at concentrations greater than background (Appendix K). The possibility that arsenic in total soil may, in fact, be present as a site-related contaminant remains a small source of uncertainty in this assessment.

This iteration of the SRA is revised from the previous April 2002 draft in response to comments from EPA Region 4 and ADEM. In addition, the comparison of site concentrations of metals to background levels for selecting site-related chemicals was updated according to the recently agreed-upon methodology (Shaw, 2003). (The site-related chemicals selected during this revision are identical to those selected in the April 2002 draft.) SSSLs, however, were not revised to reflect changes in toxicity evaluations. This imparts uncertainty to the SRA regarding two chemicals selected as COPCs in groundwater: benzene and chloroform.

Toxicity evaluation changes for benzene include an upward shift in noncancer reference doses, so that the residential SSSL for noncancer effects is approximately one and one-half times larger (less restrictive) than the value used in the SRA. The cancer slope factor, however, was also increased, so that the residential SSSL for cancer is approximately one-third lower (more restrictive) than the value used in the SRA. The STC for benzene, however, exceeds the MCL

by approximately two orders of magnitude, and the estimated ILCR and HI values that would be calculated from updated SSSLs would be greatly above acceptable limits. Therefore, the changes in the toxicity evaluation for benzene would make no meaningful difference in the ILCR or HI estimates and would have no effect on the conclusions of the SRA (see below).

The most significant change in the chloroform toxicity evaluation is the determination that the carcinogenicity of this compound is a threshold phenomenon better addressed with a reference dose than the cancer slope factor that had previously been used. Consequently, if a new SSSL had been estimated, chloroform in groundwater would not have been selected as a cancer-based COPC for the resident and the National Guardsperson. Another change is that the noncancer evaluation for chloroform is approximately 50 times less restrictive, so that the HI for the resident would be 0.27 (instead of 13.7), and chloroform would not have been selected as a noncancer COPC for the National Guardsperson. These changes, however, would have no effect on the conclusions of the SRA (see below).

6.3.6 Conclusions

Receptor scenarios evaluated for exposure at Range J included the recreational site user and venison consumer exposed to surface soil and the on-site resident and National Guardsperson exposed to total soil and groundwater.

A large number of soil and groundwater samples were analyzed for CWM breakdown products, metals, SVOCs, and VOCs. CWM breakdown products were not detected in any medium. The metals were shown to be present at concentrations comparable to background. Site-related SVOCs were limited to bis(2-ethylhexyl)phthalate in soil and 2-nitrophenol and phenol in groundwater. bis(2-Ethylhexyl)phthalate is commonly encountered wherever plastics are used. Concentrations of the SVOCs were sufficiently low so that none were chosen as COPCs. Concentrations of VOCs in soil were sufficiently low so that none were selected as COPCs. COPCs were limited to seven VOCs in groundwater.

COCs included 1,1,2,2-PCA, 1,2-DCA, benzene, carbon tetrachloride, and chloroform in groundwater. Carbon tetrachloride and chloroform appear to be widespread in groundwater. Carbon tetrachloride was detected in 19 of 42 samples evaluated, and chloroform was detected in 8 of 29 samples evaluated. Although benzene was detected in only 2 of 46 groundwater samples (less than 5 percent), it was selected as a COPC because the detected concentrations were not low (i.e., they were not near or below the reporting limits). Similarly, 1,1,2,2-PCA and 1,2-DCA were selected as COPCs, although they were detected only once in 46 samples, because they

belong to a class of compounds (chlorinated solvents) known to be present in Range J groundwater and their concentrations exceeded their respective SSSLs. It appears that the most likely source of VOCs in soil and groundwater is the decontamination procedures used for CWM at the site.

Table L-18 and the table in Section 6.3 present the overall cancer risk and noncancer hazard for all plausible receptors at Range J. Table L-19 presents the target organ selection for all noncancer COPCs for the resident. Neither HI nor ILCR values were estimated for the recreational site user or for the venison consumer because no COPCs were selected for surface soil. Evaluations for both the resident and the National Guardsperson yielded ILCR estimates that exceeded the risk management range and HI estimates that exceeded the threshold level of 1, due exclusively to groundwater contamination with VOCs. 1,2-DCA, benzene, and carbon tetrachloride are present in groundwater at levels that represent an unacceptable threat to human health. The groundwater STCs for 1,2-DCA, benzene, and carbon tetrachloride exceed their MCLs. The STCs for the other groundwater COCs fall below their MCLs, suggesting that little protection would be gained by remediating groundwater for these chemicals.

7.0 Screening-Level Ecological Risk Assessment

7.1 Introduction

In order to determine the potential for ecological risks posed by site-related chemicals at Range J, Parcel 202(7), a screening-level ecological risk assessment (SLERA) was conducted. This SLERA consisted of a description of the habitats in and around the range, a discussion of the constituents detected in samples collected from environmental media at the range, a discussion of the conceptual site model, an estimation of the screening-level risk, the identification of the constituents of potential ecological concern, an uncertainty analysis, a discussion of the different lines of evidence, and a summary of the results and conclusions.

7.2 Environmental Setting

Range J is a portion of a larger training area reportedly used since 1954. A chain-link fence surrounds a 0.16-acre area approximately 139 feet long (east to west) by approximately 50 feet wide (north to south). The larger training area, approximately 60 acres, surrounds the chain-link fence. The study area for this SLERA encompasses approximately 11 acres, including the fenced area and the surrounding area in its immediate vicinity. The study area was identified by aerial photographs and historical operation information as being the area most likely to exhibit impacts from Army activities.

Based on observations made by Shaw biologists in September 2000, the environmental setting of Range J is entirely terrestrial in nature. There are no water bodies in the near vicinity of Range J. Surface topography is generally flat over three-fourths of the site and slopes to the northwest in the western portion of the site. Generally, Range J is situated on a broad crest that slopes in all directions except to the northeast. The topography northeast of the site is flat.

The terrestrial habitat occurring at Range J falls into two general categories: “cleared” area and forested area. The cleared area is within and directly adjacent to the chain link fence. This area was formerly maintained as lawns or mowed fields. Since maintenance activities have ceased, pioneer species are now colonizing this area. Typically, the species most likely to colonize these types of areas are the “weed” species, vigorous pioneer plants that grow and spread rapidly. The first of the pioneer species to invade this abandoned area are the grasses and other herbaceous species. This formerly maintained grassy area is classified as being in an early old field successional state. Over time, the grass and other herbaceous species will be followed by shrubs and small trees. The early old field successional area at Range J is dominated by various grasses

and herbs, including dock (*Rumex spp.*), clover (*Trifolium spp.*), vetch (*Astragalus spp.*), milkweed (*Asclepias spp.*), bed straw (*Galium spp.*), ox-eye daisy (*Chrysanthemum leucanthemum*), and Johnson grass (*Sorghum halepense*). Other old field herbaceous species occurring at Range J are black raspberry (*Rubus occidentali*), poison ivy (*Toxicodendron radicans*), smooth sumac (*Rubus glabra*), green brier (*Smilax rotundiflora*), Japanese honeysuckle (*Lonicera japonica*), fox grape (*Vitis labrusca*), and multiflora rose (*Rosa multiflora*). Scrub pine (*Pinus virginiana*) and loblolly pine (*Pinus taeda*) saplings have also begun to encroach on this cleared area.

The forested area surrounding the cleared area is best characterized as mixed deciduous/coniferous forest. The canopy species typically found in the forested areas surrounding Range J include yellow poplar (*Liriodendron tulipifera*), sweetgum (*Liquidambar styraciflua*), black gum (*Nyssa sylvatica*), shortleaf pine (*Pinus echinata*), loblolly pine (*Pinus taeda*), white oak (*Quercus alba*), and northern red oak (*Quercus rubra*). The dominant understory species of this area are red maple (*Acer rubrum*), flowering dogwood (*Cornus florida*), witch hazel (*Hamamelis virginia*), sweetgum (*Liquidambar styraciflua*), wild black cherry (*Prunus serotina*), hackberry (*Celtis occidentalis*), black walnut (*Juglans nigra*), and sourwood (*Oxydendrum arboreum*). The shrub layer is dominated by mountain laurel (*Kalmia latifolia*), southern low blueberry (*Vaccinium pallidum*), southern wild raisin (*Viburnum nudum*), Virginia creeper (*Parthenocissus quinquefolia*), Christmas fern (*Lystrichum acrotichoides*), poison ivy (*Toxicodendron radicans*), and yellowroot (*Xanthorhiza simplicissima*). Numerous muscadine grape vines (*Vitis rotundifolia*) are also present in this habitat type.

Terrestrial species that may inhabit the area of Range J include opossum, short-tailed shrew, raccoon, white-tail deer, red fox, coyote, gray squirrel, striped skunk, a number of species of mice and rats (e.g., white-footed mouse, eastern harvest mouse, cotton mouse, eastern woodrat, and hispid cotton rat), and eastern cottontail. Approximately 200 avian species reside at FTMC at least part of the year (USACE, 1998). Common species expected to occur in the vicinity of Range J include northern cardinal (*Cardinalis cardinalis*), northern mockingbird (*Mimus polyglottus*), warblers (*Dendroica spp.*), indigo bunting (*Passerina cyanea*), red-eyed vireo (*Vireo olivaceus*), American crow (*Corvus brachyrhynchos*), bluejay (*Cyanocitta cristata*), several species of woodpeckers (*Melanerpes spp.*, *Picoices spp.*), and Carolina chickadee (*Parus carolinensis*). Game birds present in the vicinity of Range J may include northern bobwhite (*Colinus virginianus*), mourning dove (*Zenaida macroura*), and eastern wild turkey (*Meleagris gallopavo*). Woodland hawks (e.g., sharp-shinned hawk) were observed in this area during the ecological investigation (September 2000) and are expected to use this area for a hunting ground.

A variety of other raptors (e.g., red-tailed hawk, barred owl, and great horned owl) could also use portions of this area for a hunting ground, particularly the fringe areas where the forested areas abut roads and cleared areas.

7.3 Constituents Detected On Site

Design of the sampling and analysis programs conducted at Range J was based on a number of factors, including:

- Site history
- Results of the environmental baseline survey
- Results of previous sampling and analysis programs.

The sampling and analysis programs at Range J were described in Chapter 2.0 of this report. Constituents detected in surface soil at Range J were presented in Chapter 4.0 of this report.

In general, inorganic constituents were commonly detected in soils at Range J, but organic compounds (i.e., SVOCs and VOCs) were less frequently detected and at relatively low concentrations. Arsenic, chromium, iron, mercury, vanadium, and zinc were detected in surface soil samples at concentrations that exceeded their respective ESVs. None of these inorganic constituents exhibited patterns of contamination that would be consistent with site-related contamination (e.g., highest concentrations within the fenced-in area). Acetone was also detected in one sample at a concentration that exceeded the ESV. Although surface soil samples exhibited concentrations of bromomethane, cumene, and p-cymene, ESVs are not available for these compounds.

Surface water and sediment were not sampled at Range J because there are no surface water bodies associated with Range J.

7.4 Site Conceptual Model

The ecological site conceptual model (SCM) is a simplified, schematic diagram of possible exposure pathways and the means by which contaminants are transported from the primary contaminant source(s) to ecological receptors (Figure 7-1). The exposure scenarios include the sources, environmental transport, partitioning of the contaminants amongst various environmental media, potential chemical/biological transformation processes, and identification of potential routes of exposure for the ecological receptors. In this chapter the SCM will be described in relation to constituent fate and transport properties, the ecotoxicity of the various

Figure 7-1

Site Conceptual Model
Range J, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 1 of 2)

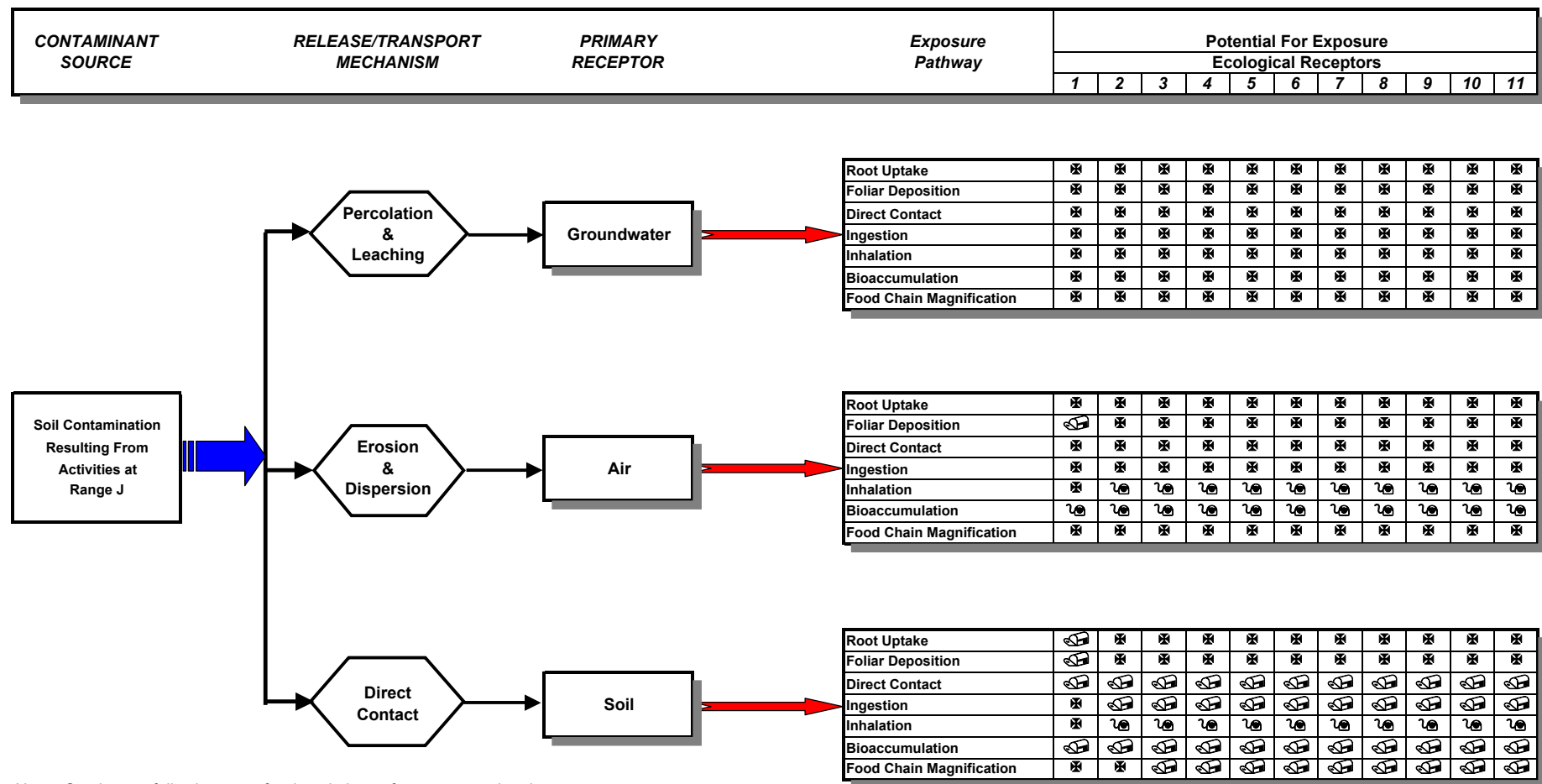


Figure 7-1




**Site Conceptual Model
for Range J
Fort McClellan, Calhoun County, Alabama**

(Page 2 of 2)

Key To Potential Receptors

- 1 - Rooted plants**
- 2 - Terrestrial Invertebrates**
- 3 - Reptiles and Amphibians**
- 4 - Herbivorous Mammals**
- 5 - Herbivorous Birds**
- 6 - Omnivorous Mammals**
- 7 - Omnivorous Birds**
- 8 - Invertivorous Mammals**
- 9 - Invertivorous Birds**
- 10 - Carnivorous Mammals**
- 11 - Carnivorous Birds**

Key To Potential Exposure Routes

-  - Potentially complete exposure pathway
-  - Incomplete exposure pathway
-  - Potentially complete exposure pathway but insignificant
- NA** - Not applicable

constituents, potential ecological receptors at Range J, and the complete exposure pathways expected to exist at Range J.

7.4.1 Constituent Fate and Transport

The environmental fate and transport of contaminants in surface soil at Range J will govern the potential for exposures to ecological receptors. In general, contaminants in environmental media may be available for direct exposure (e.g., plants exposed to surface soil), and they may also have the potential to migrate to other environmental media or areas of the site. This section discusses the mechanisms by which contaminants can be transported and the chemical properties that determine their transport.

7.4.1.1 Fate and Transport in Soil

Contaminants in surface soil at Range J have the potential to be transported from their source area to other areas within Range J and to off-site locations by a number of mechanisms, including volatilization, dust entrainment, surface runoff, and infiltration to subsurface soil/groundwater.

Several VOCs were identified in the upper soil horizons at Range J. These volatile constituents have a high potential to volatilize to the atmosphere and be transported from their source area via air movement. The concentrations of VOCs detected in surface soil at Range J are low; therefore, this transport mechanism is expected to be insignificant with respect to other transport mechanisms active at this site. Most of the metals and SVOCs in the surface soil at Range J are not expected to volatilize to any great extent, with the exception of mercury, which would be expected to volatilize relatively rapidly. Most of the metals and SVOCs in the surface soil at Range J are generally closely associated with particulate matter and would be transported from their source areas by fugitive dust generation and entrainment by the wind. Subsequent dispersion by atmospheric mixing could transport particulate-associated contaminants to other parts of Range J and to off-site locations. The generation of fugitive dust and subsequent transport by the wind is not expected to be a significant transport mechanism at Range J, based on the presence of vegetation over the vast majority of the study area.

The transport of surface soil-associated contaminants by surface runoff is another potential transport mechanism. Although the potential exists for surface runoff, there are no surface water bodies in close proximity to Range J, and the majority of the site is relatively flat. Therefore, surface runoff is expected to be an insignificant transport mechanism at Range J.

Contaminants in surface soil may be transported vertically to subsurface soils and groundwater via solubilization in rainwater and infiltration. Migration in this manner is dependent upon contaminant solubility and frequency of rainfall. Although the soil types (sand, stone, and gravel) in the vicinity of Range J are expected to promote relatively rapid infiltration of rainwater, the less soluble constituents (i.e., SVOCs) found at Range J are not likely to migrate to any great extent vertically due to their relatively low solubilities. Inorganics in soil at Range J may migrate vertically due to the acidic nature of the rainwater in this area and the increased solubility of metals that it produces.

The transfer of contaminants in surface soil to terrestrial plants through root uptake and to terrestrial animals through ingestion and other pathways is a potentially significant transfer mechanism. Many metals are readily absorbed from soil by plants, but they are not biomagnified to a great extent through the food web. Mercury is a notable exception, as it does tend to biomagnify through the food chain (Eisler, 1987). Many of the SVOCs have the potential to bioconcentrate in lower trophic level organisms (e.g., terrestrial invertebrates), but most higher trophic level animals have the ability to metabolize these compounds rapidly, precluding the potential for bioconcentration (Eisler, 1987).

VOCs in the surface soil at Range J are expected to volatilize and/or photolyze relatively rapidly when exposed to sunlight (half-lives of 3 hours to 5 days) (Burrows et al., 1989). The other surface soil contaminants (metals and SVOCs) are expected to remain in the soil relatively unchanged by physical and/or chemical processes for much longer periods of time.

7.4.1.2 Fate and Transport in Surface Water

Due to the lack of a surface water body in the near vicinity of Range J, surface water fate and transport properties are not considered significant with respect to constituents detected at Range J.

7.4.1.3 Fate and Transport in Sediment

Due to the lack of a surface water body in the near vicinity of Range J, sediment fate and transport properties are not considered significant with respect to constituents detected at Range J.

7.4.2 Ecotoxicity

The ecotoxicological properties of the constituents detected at concentrations that exceeded their respective ESVs and BTVs in surface soil at Range J are discussed in the following sections.

7.4.2.1 Arsenic

Arsenic naturally occurs as sulfides and as complex sulfides of iron, nickel, and cobalt (Woolson, 1975). In one form or another, arsenic is present in rocks, soils, water, and living organisms at concentrations of parts per billion (ppb) to parts per million (ppm) (National Academy of Sciences [NAS], 1977a). Arsenic is ubiquitous in living tissue and is constantly being oxidized, reduced, or otherwise metabolized. In soils, insoluble or slightly soluble arsenic compounds are constantly being resolubilized, and the arsenic is being presented for plant uptake or reduction by organisms and chemical processes (NAS, 1977a). In abundance of elements, arsenic ranks 20th in the Earth's crust (1.5 to 2 mg/kg), 14th in sea water, and 12th in the human body (Woolson, 1975). It occurs in various forms, including inorganic and organic compounds and trivalent and pentavalent states (Pershagen and Vahter, 1979).

Plants. The National Academy of Sciences (1977a) reports background arsenic concentrations in terrestrial plants as ranging from 0.01 to 5 mg/kg (dry weight). Generally, roots of a plant contain higher concentrations of arsenic than leaves. The toxicity of arsenic to plants may differ due to different soil conditions. Various chemical forms of arsenic have different phytotoxicities. In general, arsenates are less toxic to plants than arsenites. Concentrations of arsenic in leaf tissue that are excessive or toxic to various plant species range from 5 to 20 mg/kg (dry weight) (Kabata-Pendias and Pendias, 1992). A soil concentration of 10 mg/kg has been proposed by Efroymson et al., (1997) as a benchmark screening value for phytotoxicity in soils. General symptoms of arsenic toxicity in plants include the presence of red-brown necrotic spots on old leaves, yellowing or browning roots, depressed tillering, wilting of new leaves, and root discoloration (Kabata-Pendias and Pendias, 1992).

Terrestrial Invertebrates. Fischer and Koszorus (1992) tested the earthworm *Eisenia fetida* for effects on growth and reproduction by exposing five-week old worms to 68 mg/kg arsenic (as potassium arsenate) in soil. Reduced cocoon production was reported at this exposure level. Based on the results of this test, a soil benchmark value of 60 mg/kg has been proposed by Efroymson et al. (1997).

Mammals. Arsenic is more toxic to wildlife in the trivalent form as compared to either pentavalent arsenic or organic arsenicals. Arsenic poisoning has been reported in acute episodes but chronic arsenosis is rarely encountered (NAS, 1977a). The probability of chronic arsenic poisoning from continuous ingestion of small doses is rare, because detoxification and excretion are rapid (Woolson, 1975). General signs of arsenic toxicosis include intense abdominal pain,

staggering gait, extreme weakness, trembling, fast and feeble pulse, collapse, and death (Eisler, 1988). Adverse effects in mammals were noted in single oral doses of 2.5 to 33 mg/kg body weight and at chronic oral doses of 1 to 10 mg/kg body weight. As little as 1.7 mg/kg arsenic has been shown to produce fetal death and malformations during critical stages of hamster embryogenesis. Various species of rodents exposed to cacodylic acid through various routes exhibited lethal doses for 50 percent of the population tested (LD₅₀) ranging from 470 to 830 mg/kg body weight (Hood, 1985).

Laboratory data for arsenic toxicity (as arsenite) in laboratory mice through drinking water were used to derive a no-observed-adverse-effects level (NOAEL) value of 0.126 mg/kg per day (mg/kg/day) (Schroeder and Mitchener, 1971). Reproduction was the endpoint for these laboratory tests. Arsenic concentrations of greater than 10 mg/kg (wet weight) in tissue are usually indicative of arsenic poisoning (Goede, 1985). Detoxification and excretion of arsenic are relatively rapid processes, making the probability of chronic arsenic poisoning from the continuous ingestion of small amounts of arsenic a rare event (Eisler, 1988a).

Birds. As with mammals, arsenic poisoning in birds has been reported in acute episodes but chronic arsenosis is rarely encountered. Signs of inorganic trivalent arsenite poisoning in birds include muscular incoordination, debility, slowness, jerkiness, falling hyperactivity, immobility, and seizures (Eisler, 1988a). Studies reported by Hudson et al. (1984) using mallard ducks (*Anas platyrhynchos*) fed sodium arsenite determined a lethal concentration for 50 percent of the test population (LC₅₀) of 323 mg/kg body weight. Copper acetoarsenite fed to the northern bobwhite (*Colinus virginianus*) at 480 mg/kg proved fatal to 50 percent of the test organisms in 11 days (NAS, 1977a). The grey partridge (*Perdix perdix*) succumbed to 300 mg/kg body weight of lead arsenate in 52 hours (NAS, 1977a).

Brown-headed cowbirds fed arsenic in their diets for seven months experienced mortality at doses as low as 75 ppm. These data were used to derive a NOAEL value of 2.46 mg/kg/day (USFWS, 1969). Data from a study of mallard ducks fed arsenic in their diets for 128 days were used to derive a NOAEL value of 5.14 mg/kg/day (USFWS, 1964). Mortality was the endpoint for both of these studies.

Aquatic Life. Toxic and other effects of arsenicals to aquatic life are significantly modified by numerous biological and abiotic factors (Woolson, 1975; NAS, 1977a; National Research Council of Canada [NRCC], 1978; Howard et al., 1984; Michnowicz and Weeks, 1984; Bryant et al., 1985; EPA, 1985a; Sanders, 1986). The LC₅₀ values, for example, are markedly affected by

water temperature, pH, oxidation-reduction potential, organic content, phosphate concentration, suspended solids, and presence of other substances and toxicants, as well as arsenic speciation, and duration of exposure. In general, inorganic arsenicals are more toxic than organoarsenicals to aquatic biota, and trivalent species are more toxic than pentavalent species. Early life stages are most sensitive, and large interspecies differences have been recorded, even among those closely related taxonomically. Juvenile bluegills (*Lepomis machrochirus*) exhibited reduced survival after sixteen weeks when exposed to a single treatment of trivalent arsenic at 0.69 mg/L (EPA, 1985a). An adult bluegill population was reduced 42 percent after several monthly applications of 4 mg/L trivalent arsenic (NAS, 1977a).

As with fish, toxic and other effects of arsenicals to aquatic invertebrates are significantly modified by numerous biological and abiotic factors (Woolson, 1975; NAS, 1977a; NRCC, 1978; Howard et al., 1984; Michnowicz and Weak, 1984; Bryant et al., 1985; EPA, 1985a; Sanders, 1986). The cladoceran *Daphnia magna* population exposed to 4.3 mg/L trivalent arsenic exhibited a 50 percent immobilization after 96 hours, and the amphipod *Gammarus pseudolimnaeus* experienced 50 percent immobilization following 96 hours of 0.96 mg/L trivalent arsenic exposure (Lima et al., 1984).

7.4.2.2 Chromium

Chromium exists in soil primarily in the form of insoluble oxides with very limited mobility. In soil, chromium (+3) is readily hydrolyzed and precipitated as chromium hydroxide. In the aquatic phase, chromium may be in the soluble state or attached to clay-like or organic suspended solids.

Plants. Chromium does not play an essential role in plant metabolism. The concentration of chromium in terrestrial plants is controlled primarily by soluble chromium in the soil (Kabata-Pendias and Pendias, 1992). Chromium concentrations in plants are usually higher in roots than in leaves or shoots. Concentrations of chromium in leaf tissue that are excessive or toxic to various plant species range from 5 to 30 mg/kg soil (Kabata-Pendias and Pendias, 1992). General symptoms of chromium toxicity in plants include chlorosis of new leaves, necrotic spots and purpling tissues, and injured root growth (Kabata-Pendias and Pendias, 1992).

Terrestrial Invertebrates. Abbasi and Soni (1983) exposed the earthworm *Octochaetus pattoni* to chromium (as $K_2Cr_2O_7$) in soil for 60 days to assess the effects on survival and reproduction. Survival was the most sensitive endpoint with a 75 percent decrease resulting from exposure to 2.0 ppm chromium, the lowest concentration tested. The number of cocoons

produced was not reduced until the concentration reached 20 ppm chromium (the highest concentration tested). The number of juveniles produced was not affected.

It is difficult to establish a benchmark concentration for chromium based on earthworm toxicity because the relative toxicity of Cr^{+3} and Cr^{+6} is not clear from the available data. Cr^{+6} ions can pass through cell membranes with much greater ease than Cr^{+3} ions. However, it is thought that Cr^{+6} is reduced to Cr^{+3} inside the cell (Molnar et al., 1989). Without a better understanding of chromium transformations in the soil, transport across earthworm cell membranes, and reactions within the cell, it is difficult to separate the effects of the two different forms of chromium. These difficulties notwithstanding, a soil benchmark value of 0.4 mg/kg has been suggested by Efroymson et al. (1997), based on the work of Abbasi and Soni (1983).

Mammals. Chromium is a required element in animal nutrition. In general, hexavalent chromium compounds are more toxic than the trivalent chromium compounds. Adverse effects on blood and serum chemistry and morphological changes in liver have been reported in rabbits and rats exposed to chromium concentrations of 1.7 mg/kg/day for six weeks. Rats exposed to hexavalent chromium concentrations of 134 mg/L in drinking water over a two to three month period were found to develop lesions in kidney and liver tissues (Eisler, 1986).

Laboratory data based on rats exposed to chromium (as Cr_2O_3) in their diets were used to derive a NOAEL value for trivalent chromium of 2,737 mg/kg/day (Ivankovic and Preussmann, 1975). Reproduction and longevity were the endpoints in this study. Laboratory data based on rats exposed to chromium (as $\text{K}_2\text{Cr}_2\text{O}_4$) in their drinking water were used to derive a NOAEL value for hexavalent chromium of 3.28 mg/kg/day (Mackenzie et al., 1958). Body weight and food consumption were the endpoints in this study. Mammalian laboratory studies have shown chromium to be mutagenic, carcinogenic, and teratogenic (Eisler, 1986).

Birds. Data on the effects of chromium to avian species are limited. No adverse effects were found in chickens exposed to 100 mg/kg dietary hexavalent chromium in a 32-day study (Rosomer et al., 1961). Haseltine et al. (1985) did not observe changes in survival, reproduction or blood chemistry following exposure of adult black ducks (*Anas rubripes*) to diets containing between 10 and 50 mg/kg chromium III (as $\text{CrK}[\text{SO}_4]_2$). Ducklings from this group that were fed the same chromium diet as the parent ducks experienced alterations in growth patterns and a reduction in survival. Based on these data, a NOAEL value of 1 mg/kg/day has been derived.

Aquatic Life. In freshwater systems, hexavalent chromium appears to be more toxic than the trivalent form. The National Recommended Water Quality Criteria for trivalent chromium are 570 µg/L for acute exposures and 74 µg/L for chronic exposures. The National Recommended Water Quality Criteria for hexavalent chromium are 16 µg/L for acute exposures and 11 µg/L for chronic exposures (EPA, 1999a). These values are based on a water hardness of 100 mg/L.

The test EC₂₀ for fish can be used as a benchmark indicative of production within a population. It is the highest tested concentration causing less than 20 percent reduction in either the weight of young fish per initial female fish in a life-cycle or partial life-cycle test, or the weight of young per egg in an early life-stage test. The EC₂₀ value for trivalent chromium is 89 µg/L and for hexavalent chromium is 51 µg/L (Suter and Tsao, 1996). A similar value can be determined for daphnids that represents the highest tested concentration causing less than 20 percent reduction in the product of growth, fecundity, and survivorship in a chronic test with a daphnid species. The EC₂₀ benchmark for daphnids has been determined to be 0.5 µg/L for hexavalent chromium (Suter and Tsao, 1996).

7.4.2.3 Iron

Iron is an essential trace element, required as a constituent of oxygen-carrying and oxidative-reductive macro-molecules such as hemoglobin, myoglobin, and cytochrome P-450. As such, most iron-related health concerns are induced by insufficient iron intake, rather than excess iron intake (National Research Council, 1989).

Plants. Wallihan (1966) reported unspecified reductions in plant growth in a solution culture with the addition of 10 ppm iron. Wallace et al. (1977) evaluated the effects of iron (as FeSO₄) on leaf, stem, and root weights of bush bean seedlings grown for fifteen days in nutrient solution. Iron at 28 ppm reduced all three measures 67, 52, and 67 percent, respectively, while 11.2 ppm iron had no effect. After 55 days cabbage seedling plant weight was reduced 45 percent by 50 ppm iron added as FeSO₄ to nutrient solution, while 10 ppm had no effect on growth (Hara et al., 1976).

Iron is the key metal required for energy transformations needed for cellular function. It occurs in heme and non-heme proteins and is concentrated in chloroplasts. Organic iron complexes are involved in photosynthetic electron transfer. Plant symptoms of toxicity are not specific and differ among plant species and growth stages (Foy et al., 1978).

Terrestrial Invertebrates. No information was found regarding the toxicity of iron to terrestrial invertebrates.

Mammals. Iron is an essential nutrient for most wildlife species and is necessary to maintain homeostasis; therefore, it is toxic only at very high concentrations. Bioaccumulation factors have been calculated for several small mammal species. Small herbivorous mammals were estimated to have an iron bioaccumulation factor of 0.0127, and small omnivorous mammals were estimated to have an iron bioaccumulation factor of 0.01209. These bioaccumulation factors indicate that iron is not accumulated in small mammal tissues (Sample et al., 1998). Additionally, the bioaccumulation factor for earthworms has been estimated to be 0.038, indicating that iron is not accumulated in earthworm tissues (Sample et al., 1998).

Aquatic Life. The National Recommended Water Quality Criteria for iron (1,000 µg/L) is based on field study at a site receiving acid mine drainage. The lowest chronic value for daphnids (158 µg/L) is a threshold for reproductive effects from a 21-day test using iron chloride with *Daphnia magna* (Dave, 1984). It is considerably lower than the 4,380 µg/L concentration causing 16 percent reproductive decrement in another test using iron chloride with *Daphnia magna* (Biesinger and Christensen, 1972). The lowest chronic value for fish (1,300 µg/L) is a concentration that caused 100 percent mortality in an embryo-larval test with rainbow trout exposed to dissolved iron salts (Amelung, 1981).

The Ontario Ministry of the Environment has prepared provincial sediment quality guidelines using the screening-level concentration approach, which estimates the highest concentration of a particular contaminant in sediment that can be tolerated by approximately 95 percent of benthic fauna (Neff et al., 1988). These values are based on Ontario sediments and benthic species from a wide range of geographical areas within the province (Persaud et al., 1993). The lowest effect level (Low) is the level at which actual ecotoxic effects become apparent. The severe effect level (Severe) represents contaminant levels that could potentially eliminate most of the benthic organisms (Persaud et al., 1993). The “Low” and “Severe” levels for iron in sediment are 2 percent (20,000 ppm) and 4 percent (40,000 ppm), respectively.

7.4.2.4 Mercury

Mercury is a toxic compound with no known natural biological function. Mercury exists in three valence states: mercuric (Hg^{2+}), mercurous (Hg^{1+}), and elemental (Hg^{0+}) mercury. It is present in the environment in inorganic and organic forms. Inorganic mercury compounds are less toxic than organomercury compounds; however, the inorganic forms are readily converted to organic

forms by bacteria commonly present in the environment. The organomercury compound of greatest concern is methylmercury (EPA, 1999a).

Mercury sorbs strongly to soil and sediment. Elemental mercury is highly volatile. In aquatic and terrestrial receptors, some forms of mercury, especially organomercury compounds, bioaccumulate significantly and biomagnify in the food chain. In all receptors, the target organs are the kidney and central nervous system. However, mercury causes numerous other effects, including teratogenicity and mutagenicity (EPA, 1999a).

Plants. Mercury is not required for plant growth. Background concentrations of mercury in plants usually range from 0.0026 to 0.086 mg/kg (dry weight) (Kabata-Pendias and Pendias, 1992). Pine needles have been reported to be good biomonitors of mercury-contaminated environments (Kabata-Pendias and Pendias, 1992). In general, the concentration of mercury in plants will be elevated when mercury concentrations in soils are high. Mercury concentrations in plants, however, generally do not exceed those in associated soils (Lisk, 1972). Methyl mercury is more available to plants than either phenyl- or sulfide-mercury. In addition to mercury uptake from the soil, plants can also absorb mercury vapor (Browne and Fang, 1978).

Concentrations of mercury in leaf tissue that are excessive or toxic to various plant species range from 1 to 3 mg/kg (dry weight) (Kabata-Pendias and Pendias, 1992). A soil concentration of 0.3 mg/kg has been proposed by Efroymson et al. (1997) as a benchmark screening value for mercury phytotoxicity. General symptoms of mercury toxicity in plants include severe stunting of seedlings and roots and leaf chlorosis and browning of leaf points (Kabata-Pendias and Pendias, 1992).

Terrestrial Invertebrates. Abbasi and Soni (1983) exposed earthworms (*Octochaetus pattoni*) to mercury (as HgCl) to assess the effect on reproduction and growth. Survival and cocoon production were reduced at 0.5 ppm mercury, the lowest concentration tested. The number of juveniles produced was not affected. Based on these test data, a benchmark value for mercury in soil of 0.1 mg/kg has been proposed by Efroymson et al. (1997).

Mammals. Mercury is not an essential element for animal life. Background mercury concentrations in wildlife tend to be less than 1.0 mg/kg (wet weight) (Eisler, 1987). Biomonitoring studies have shown that mercury concentrations in mammals are highest in hair, followed by kidney and liver tissues (Bull et al., 1977; Klaassen, 1991; Wren, 1986). Mercury is bioaccumulated and biomagnified in terrestrial food chains (Eisler, 1987; Talmage and Walton,

1993). Talmage (1989) has shown the insectivorous shorttail shrew (*Blarina brevicauda*) to be a better monitor of environmental mercury contamination than the granivorous white-footed mouse (*Peromyscus leucopus*). Mink (*Mustela vison*) and river otter (*Lutra canadensis*) have been shown to be good monitors of mercury contamination within river environments due to their consumption of contaminated fish (Kucera, 1983).

Organic mercury compounds, especially methyl mercury, are more toxic to mammals than inorganic forms of mercury. Selenium has been shown to have a protective effect against mercury poisoning (Ganter et al., 1972). Based on laboratory data for methylmercury fed to rats and mink in their diets, a NOAEL value of 0.015 has been derived. This NOAEL is based on mortality, weight loss, reproduction, and ataxia as endpoints (Wobeser et al., 1976).

Mercury has been shown to be teratogenic, mutagenic, and carcinogenic in animal studies (Eisler, 1987). Signs of mercury poisoning that have been observed in mink include anorexia, weight loss, ataxia and splaying of hind legs, irregular vocalization, salivation, and convulsions (Wren, 1986).

Birds. Concentrations of mercury that are acutely toxic to birds following oral exposure range from 2.2 to 31 mg/kg body weight (Eisler, 1987). Mercury concentrations in the livers of methylmercury-poisoned birds ranged from 17 to 70 mg/kg (dry weight) (Solonen and Lodenius, 1984). Methylmercury is more toxic to avian species than inorganic mercury (Hill, 1981). In addition to the form of mercury to which the bird is exposed, the species, gender, age, and health of the individual may also influence the toxic response (Fimreite, 1979). Physical signs of mercury poisoning in birds include muscular incoordination, falling, slowness, fluffed feathers, calmness, withdrawal, hyporeactivity, and eyelid drooping (Eisler, 1987).

Japanese quail were fed mercury in their diet for one year to study the effects on reproduction. Egg production increased with increasing mercury dose, while fertility and hatchability decreased. Adverse effects of mercury exposure were evident at the 8 mg/kg dose level. Based on the results of this study, a NOAEL value of 0.45 mg/kg/day has been derived (Hill and Schaffner, 1976). Mallard ducks fed methylmercury dicyandiamide in their diets produced fewer eggs and fewer ducklings at exposure levels as low as 0.5 mg/kg. A NOAEL value of 0.0064 mg/kg/day was derived from these data, with reproduction the endpoint studied (Heinz, 1979).

Aquatic Life. Concentrations of mercury in freshwater fish collected from 12 monitoring stations in the United States from 1978 to 1981 ranged from 0.1 to 1.1 mg/kg (wet weight), with

an average of 0.11 mg/kg (Lowe et al., 1985). Elevated concentrations of mercury in fish have often been associated with low pH, low calcium concentrations in the water, and low water hardness (Eisler, 1987). Methylating bacteria in sediments actively convert inorganic mercury into methylmercury. This results in an increase in the bioavailability of mercury. Fish absorb methylmercury more easily than inorganic mercury from the water column (Huckabee et al., 1979). Because exposure of fish to methylmercury can occur via ingestion of contaminated prey, methylmercury concentrations are usually highest in organisms near the top of the food chain, such as carnivorous fish (Huckabee et al., 1979).

Exposure of aquatic organisms to elevated mercury concentrations can result in reduced growth and reproduction (Eisler, 1987). The National Recommended Water Quality Criteria for acute and chronic exposure to mercury in freshwater systems are 1.4 and 0.77 µg/L, respectively (EPA, 1999a). The test EC₂₀ for fish can be used as a benchmark indicative of production within a population. It is the highest tested concentration causing less than 20 percent reduction in either the weight of young fish per initial female fish in a life-cycle or partial life-cycle test, or the weight of young per egg in an early life-stage test. The EC₂₀ value for methylmercury is less than 0.03 µg/L (Suter and Tsao, 1996). A similar value can be determined for daphnids that represents the highest tested concentration causing less than 20 percent reduction in the product of growth, fecundity, and survivorship in a chronic test with a daphnid species. The EC₂₀ benchmark for daphnids has been determined to be 0.87 µg/L (Suter and Tsao, 1996).

Physical signs of acute mercury poisoning in fish include the flaring of gills, an increase in the frequency of respiratory movements, loss of equilibrium, and sluggishness (Armstrong, 1979).

7.4.2.5 Vanadium

Vanadium, a white to gray metal, occurs naturally in fuel oils and coal. It is used as a catalyst in the production of various chemicals, including sulfuric acid. It is also used in the hardening of steel, the manufacture of pigments, and in photography. The general population and many ecological receptors are exposed to background levels of vanadium primarily through ingestion of food.

Plants. There is some controversy over whether vanadium is an essential element for plants (Kabata-Pendias and Pendias, 1992). It appears to be required by some algal species and may be required by nitrogen-fixing bacteria. Mean background concentrations of vanadium in plants are 1.6 mg/kg for angiosperms, 0.69 mg/kg for gymnosperms, and 0.67 mg/kg for fungi (Waters, 1977). The availability of vanadium to plants is highly dependent on soil pH. Elevated levels of

vanadium in soil can reduce the uptake of manganese, copper, calcium, and phosphorus (NRCC, 1980).

Concentrations of vanadium in leaf tissue that are excessive or toxic to various plant species range from 5 to 10 mg/kg (dry weight) (Kabata-Pendias and Pendias, 1992). A soil concentration of 2 mg/kg has been proposed by Efroymson et al. (1997) as a benchmark screening value for vanadium phytotoxicity.

Terrestrial Invertebrates. No information was found regarding the toxicity of vanadium to terrestrial invertebrates.

Mammals. Vanadium has been shown to be essential in the diets of rats (Waters, 1977). Background concentrations of vanadium in the kidneys and livers of wild mammals have been reported to range from 0 to 2.07 mg/kg, and from 0 to 0.94 mg/kg, respectively (Waters, 1977). Liver and skeletal tissues usually contain the highest concentrations of vanadium (Waters, 1977). Experimental animal investigations have suggested that the liver, adrenal, and bone marrow may be adversely affected by subacute exposure to high levels of vanadium (Agency for Toxic Substances and Disease Registry, 1992; Klaassen et al., 1991). Vanadium fed to rats prior to gestation, during gestation, and through delivery and lactation was studied for effects on reproduction. The rats were fed three dose levels (5, 10, and 20 mg NaVO₃/kg/day or 2.1 mg V/kg/day). Significant differences in reproductive parameters (e.g., number of dead young per litter, size and weight of offspring) were observed at all dose levels. Therefore, the lowest dose was considered to be a chronic lowest-observed-adverse effect level (LOAEL). A chronic NOAEL was estimated by applying an uncertainty factor of 0.1 (chronic NOAEL = 0.21 mg V/kg/day) (EPA, 1999b).

Based on oral intubation exposure of rats to sodium metavanadate by Domingo et al. (1986), an estimated NOAEL value of 0.21 mg/kg/day has been derived. Reproduction was the endpoint for this study. Signs of acute toxicity in animals include alterations in nervous system responses, gastrointestinal distress, hemorrhaging, paralysis, convulsions, and respiratory depression (Klaassen et al., 1991).

Birds. Mallard ducks were fed vanadium as vanadyl sulfate in their diet for 12 weeks and observed for effects on mortality, body weight, and blood chemistry. The ducks were fed three different doses (2.84, 10.36, and 110 ppm V). No effects were observed at any of the dose levels. Because this study was greater than ten weeks in duration and did not consider a critical

life stage, the maximum dose was considered to be a chronic NOAEL (White and Dieter, 1978). From these data a NOAEL value of 11.4 mg/kg/day has been estimated.

Aquatic Life. Background concentrations of vanadium in freshwater fish are usually less than 2.5 mg/kg (wet weight) (Jenkins, 1980). A bioconcentration factor of 3,000 has been reported for aquatic invertebrates exposed to vanadium (Neumann, 1976). No federal ambient water quality criteria exist for the protection of freshwater biota (EPA, 1999a). The test EC₂₀ for fish can be used as a benchmark indicative of production within a population. It is the highest tested concentration causing less than 20 percent reduction in either the weight of young fish per initial female fish in a life-cycle or partial life-cycle test, or the weight of young per egg in an early life-stage test. The EC₂₀ value for vanadium is 41 µg/L (Suter and Tsao, 1996). A similar value can be determined for daphnids that represents the highest tested concentration causing less than 20 percent reduction in the product of growth, fecundity, and survivorship in a chronic test with a daphnid species. The EC₂₀ benchmark for daphnids has been determined to be 430 µg/L (Suter and Tsao, 1996).

7.4.2.6 Zinc

Zinc is a naturally occurring element that can be found in both organic and inorganic forms and, as such, is commonly found in the environment. In general, zinc is concentrated in the sediments of water bodies. NAS (1977b) has reported that zinc will probably be detected in 75 percent of all water bodies examined for the compound at various locations. The fate of zinc in soils appears to have a pH basis. Studies have shown that a pH of less than 7 often favors zinc desorption (EPA, 1984).

Plants. Background concentrations of zinc in terrestrial plants range from 25 to 150 mg/kg (dry weight) (NAS, 1979). The deficiency content of zinc in plants is between 10 and 20 ppm (dry weight). Roots often contain the highest concentrations of zinc (Kabata-Pendias and Pendias, 1992).

Certain species of plants, particularly those from the families *Caryophyllaceae*, *Cyperaceae*, and *Plumbaginaceae*, and some tree species are extremely tolerant to elevated zinc concentrations (Kabata-Pendias and Pendias, 1992). Concentrations of zinc in these plants may reach 1 percent (dry weight) in the plant. Concentrations in leaf tissue that are excessive or toxic to various plant species range from 100 to 400 mg/kg. Concentrations of 100 to 500 mg/kg are expected to result in a 10 percent loss in crop yield (Kabata-Pendias and Pendias, 1992). General symptoms of zinc toxicity in plants include the presence of chlorotic and necrotic leaf tips, interveinal

chlorosis in new leaves, retarded growth of the entire plant, and injured roots that resemble barbed wire (Kabata-Pendias and Pendias, 1992).

Terrestrial Invertebrates. Spurgeon and Hopkin (1996) exposed the earthworm *Eisenia fetida* to zinc in soils with differing organic matter content and soil pH. The EC₅₀ concentrations for cocoon production in soils with a pH of 7.0 and 5 percent, 10 percent, and 15 percent organic matter were 136, 462, and 592 mg/kg, respectively. The EC₅₀ concentrations for cocoon production in soils of pH 6.0 and 5 percent, 10 percent, and 15 percent organic matter were 199, 343, and 548 mg/kg, respectively. The EC₅₀ concentrations for cocoon production in soils of pH 5.0 and 5 percent, 10 percent, and 15 percent organic matter were 142, 189, and 230 mg/kg, respectively. Mortality was observed at higher zinc concentrations. A decrease in pH and/or organic matter content in soil led to a lower toxic concentration of zinc.

Neuhauser et al. (1985) determined an LC₅₀ for zinc in soil using adult *Eisenia fetida* exposed for 14 days. The calculated LC₅₀ was 662 mg/kg. Data from the preceding studies were used to derive a soil benchmark value for zinc in soil of 100 mg/kg (Efroymson et al., 1997).

Mammals. Zinc is an essential trace element for normal fetal growth and development. However, exposure to high levels of zinc in the diet has been associated with reduced fetal weights, altered concentrations of fetal iron and copper, and reduced growth in offspring (Cox et al., 1969). Poisoning has been observed in ferrets and mink from chewing corroded galvanized cages (Clark et al., 1981). Symptoms of zinc toxicity are lassitude, slower tendon reflexes, bloody enteritis, diarrhea, lowered leukocyte count, depression of the central nervous system, and paralysis of the extremities (Venugopal and Luckey, 1978). A study by Kinnamon (1963) showed a NOAEL for oral exposure to a zinc compound over a period of 73 days to be 250 mg/kg body weight, and mice given 500 mg/L of zinc, as zinc sulfate, in drinking water have shown hypertrophy of the adrenal cortex and pancreas. Young animals are much more susceptible to poisoning by zinc than are mature animals (Clark et al., 1981).

Animals are quite tolerant to high concentrations of zinc in the diet. Levels 100 times that required in the diet usually do not cause detectable symptoms of toxicosis (NAS, 1979). Laboratory data for rats exposed to zinc oxide in their diet were used to estimate a NOAEL value of 160 mg/kg/day (Schlicker and Cox, 1968). Reproduction was the endpoint studied. Symptoms of zinc poisoning in mammals include lameness, acute diarrhea, and vomiting (Eisler, 1993).

Birds. Dietary zinc concentrations of greater than 2,000 mg/kg diet are known to result in reduced growth of domestic poultry and wild birds (Eisler, 1993). Reduced survival has been documented at zinc concentrations greater than 3,000 mg/kg diet or at a single dose of greater than 742 mg/kg body weight (Eisler, 1993). Laboratory data for white leghorn hens exposed to zinc sulfate in their diet for 44 weeks were used to estimate a NOAEL value of 14.5 mg/kg/day (Stahl et al., 1990). Reproduction was the endpoint for this study. A value of 51 mg/L has been calculated as the NOAEL for chronic exposure of birds to zinc carbonate in drinking water (Sample et al., 1996).

Aquatic Life. Zinc residues in freshwater and marine fish are generally much lower than those found in algae and invertebrates. Thus there is little evidence for accumulation (Moore and Ramamoorthy, 1984). Rainbow trout (*Oncorhynchus mykiss*) have the ability to detect and avoid areas of water containing 5.6 ppb zinc (Sprague, 1968). Cairns and Scheier (1968) reported 96-hour LC₅₀s ranging from 10.13 to 12.5 ppm in hard water for bluegills (*Lepomis macrochirus*), and 96-hour LC₅₀s ranging from 2.86 to 3.78 ppm in soft water. These results demonstrate that water hardness affects the toxicity of zinc to fish. Chronic toxicity tests have been conducted with five species of freshwater fish. Chronic values ranged from 47 µg/L for flagfish (*Jordanella floridae*) to 852 µg/L for brook trout (*Salvelinus fontinalis*) (EPA, 1980).

Acute toxicity to freshwater invertebrates is relatively low and, as with other metals, increasing water hardness decreases the toxicity of zinc (Moore and Ramamoorthy, 1984). As reported by Baudouin and Scoppa (1974), the 48-hour LC₅₀ for the cladoceran *Daphnia hyalina* was 0.055 mg/L, and 5.5 mg/L for the copepod *Cyclops abyssorum*. Four chronic toxicity tests are reported for *Daphnia magna*, with chronic values ranging from 47 µg/L to 136 µg/L (EPA, 1980). Chronic testing with the saltwater species *Mysidopsis bahia* resulted in a chronic value of 166 µg/L (EPA, 1980).

7.4.2.7 Acetone

Acetone is a highly volatile organic compound. It exists almost exclusively in the vapor phase in the atmosphere. Volatilization and biodegradation are the major fate processes affecting acetone released to soil, surface water, or sediment. Routes of exposure or wildlife include ingestion, inhalation, and dermal uptake. Acetone is not bioconcentrated in aquatic organisms and is not bioaccumulated by mammals or birds. Therefore, it does not bioaccumulate or bioconcentrate in aquatic or terrestrial food chains (EPA, 1999b).

Plants. No information was found regarding the toxicity of acetone to plants.

Mammals. Acetone is a highly volatile compound and may be inhaled in large quantities. Acetone is very water soluble, so it is quickly absorbed into the blood stream following inhalation and is dispersed throughout the body. A large portion of acetone is excreted primarily unchanged through the lungs and urine, with only a small portion reduced and excreted as carbon dioxide. Because acetone is quickly eliminated, wildlife receptors will not accumulate it in tissues (EPA, 1999b). Acute toxic effects following ingestion of 50 milliliters or more may include ataxia, sedation, and coma; respiratory depression; gastrointestinal disorders; hyperglycemia and ketonemia; acidosis; and hepatic and renal lesions (Krasavage et al., 1982). Subchronic oral exposures are associated with kidney damage and hematological changes.

Rats exposed to 100, 500, and 2,500 mg/kg/day acetone via oral intubation exhibited significant liver and kidney damage at 500 and 2,500 mg/kg dose levels. Because no significant differences were observed at the 100 mg/kg/day dose level and the study considered exposure for 90 days and did not include critical life stages (e.g., reproduction), this dose was considered to be the subchronic NOAEL. The chronic NOAEL was estimated to be 10 mg/kg/day, based on an uncertainty factor of 0.1 (EPA, 1986a)

Terrestrial Invertebrates. No information was found regarding the toxicity of acetone to terrestrial invertebrates.

Birds. No information was found regarding the toxicity of acetone to birds.

Aquatic Life. In most aquatic systems, acetone will exist in water rather than sediment, due to its high water solubility and low sediment adsorption coefficient. Bioaccumulation does not occur in aquatic organisms, as suggested by its low log K_{ow} value (Rathburn et al., 1982). Adult haddock tested under static conditions at 7.9 °C showed a bioconcentration factor of 1.0 for acetone (Rustung et al., 1931). Biomagnification along the aquatic food chain is also considered insignificant for acetone, as suggested by its low K_{ow} value.

The cladoceran *Daphnia magna* exposed to acetone concentrations of 15,072 mg/L exhibited reduced survival, narcosis, and death (Pawlisz and Peters, 1993). The Tier II Secondary Acute and Chronic Values for acetone calculated using the methods proposed in the *Final Water Quality Guidance for the Great Lakes System* (EPA, 1995) were 28,000 and 1,500 µg/L, respectively. The lowest test EC₂₀ for fish (extrapolated from 96-hour LC₅₀ values using equations from Suter, 1992) has been estimated to be 161,867 µg/L. The secondary chronic

value of 1,500 µg/L has been proposed as a preliminary remediation goal for acetone in surface water (Efroymson et al., 1997).

7.4.3 Potential Receptors

Potential ecological receptors at Range J are limited to terrestrial species, since there are no water bodies associated with Range J. There are several major feeding guilds that could be expected to occur at Range J: herbivores, invertivores, omnivores, and carnivores. All of these feeding guilds are expected to be directly exposed to soil-related constituents at Range J via various activities (e.g., feeding, grooming, bathing). These feeding guilds may also be exposed to site-related chemicals via food web transfers.

7.4.3.1 Herbivorous Feeding Guild

The major route of exposure for herbivores is through ingestion of plants that may have accumulated contaminants from the soil. The vegetation at the formerly maintained areas of Range J is mainly grasses, sedges, and shrubs, which are remnants of the maintained grass that was present when Range J was operational. Since terrestrial herbivores by definition are grazers and browsers, they could be exposed to chemicals that have accumulated in the vegetative tissues of plants at the site. Terrestrial herbivores may also be exposed to site-related chemicals in soil through incidental ingestion of soil while grazing, grooming, or other activities.

Dermal absorption of PAHs from soil is a potential exposure pathway for herbivores at Range J; however, mammals and birds are less susceptible to dermal exposures because their fur or feathers prevent skin from coming into direct contact with the soil (EPA, 1993). Dermal absorption of inorganic compounds from direct contact with soil is expected to be minimal due to the low dermal permeability of these compounds. Inhalation of volatile compounds (e.g., mercury, acetone) from surface soil is a viable exposure pathway. Inhalation of constituents sorbed to soil particles and inhaled as dust is a potential exposure pathway for herbivores; however, the nearly continuous vegetative cover at Range J effectively reduces the potential for dust generation.

Typical herbivorous species expected to occur at Range J and commonly used as sentinel species in ecological risk assessment include eastern cottontail (*Sylvilagus floridanus*), eastern gray squirrel (*Sciurus carolinensis*), pine vole (*Pitymys pinetorum*), whitetail deer (*Odocoileus virginianus*), and wild turkey (*Meleagris gallopavo*).

7.4.3.2 Invertivorous Feeding Guild

Invertivores specialize in eating insects and other invertebrates. As such, they may be exposed to site-related chemicals that have accumulated in insects and other invertebrates. Invertivores may also be exposed to site-related chemicals in soil through incidental ingestion of soil while probing for insects, grooming, or other activities. Ingestion of soil while feeding is potentially a major exposure pathway for invertivores, since much of their food (i.e., earthworms and other invertebrates) lives on or below the soil surface.

Dermal absorption of PAHs from soil is a potential exposure pathway for invertivores at Range J; however, mammals and birds are less susceptible to dermal exposures because their fur or feathers prevent skin from coming into direct contact with the soil (EPA, 1993). Dermal absorption of inorganic compounds from direct contact with soil is expected to be minimal due to the low dermal permeability of these compounds. Inhalation of volatile compounds (e.g., mercury, acetone) from surface soil is a viable exposure pathway. Inhalation of constituents sorbed to soil particles and inhaled as dust is a potential exposure pathway for invertivores; however, the nearly continuous vegetative cover at Range J effectively reduces the potential for dust generation.

Typical invertivorous species expected to occur at Range J and commonly used as sentinel species in ecological risk assessment include American woodcock (*Philohela minor*), carolina wren (*Thryothorus ludovicianus*), shorttail shrew (*Blarina brevicauda*), and eastern mole (*Scalopus aquaticus*).

7.4.3.3 Omnivorous Feeding Guild

Omnivores consume both plant and animal material in their diet, depending upon availability. Therefore, they could be exposed to chemicals that have accumulated in the vegetative tissues of plants at the site and also chemicals that may have accumulated in smaller animal tissues that the omnivores prey upon. Omnivores may also be exposed to site-related chemicals in soil through incidental ingestion of soil while feeding, grooming, or other activities.

Dermal absorption of PAHs from soil is a potential exposure pathway for omnivores at Range J; however, birds and mammals are less susceptible to dermal exposures because their feathers or fur prevent skin from coming into direct contact with the soil (EPA, 1993). Dermal absorption of inorganic compounds from direct contact with soil is expected to be minimal due to the low dermal permeability of these compounds. Inhalation of volatile compounds (e.g. mercury, acetone) is a viable exposure pathway at Range J. Inhalation of constituents sorbed to soil

particles and inhaled as dust is a potential exposure pathway for omnivores; however, the nearly continuous vegetative cover at Range J effectively reduces the potential for dust generation.

Typical omnivorous species expected to occur at Range J and commonly used as sentinel species in ecological risk assessment include red fox (*Vulpes fulva*), white-footed mouse (*Peromyscus leucopus*), and American robin (*Turdus migratorius*).

7.4.3.4 Carnivorous Feeding Guild

Carnivores are meat-eating animals and are, therefore, exposed to site-related chemicals through consumption of prey animals that may have accumulated contaminants in their tissues.

Carnivores are quite often top predators in a local food web and are often subject to exposure to contaminants that have biomagnified through the food web. Food web exposures for carnivores are based on the consumption of prey animals that have accumulated COPECs by various means. Smaller herbivores, omnivores, invertivores, and other carnivores may consume soil, surface water, sediment, plant, and animal material as food and accumulate COPECs in their tissues. Subsequent ingestion of these prey animals by carnivorous animals would expose them to COPECs. Most inorganic and volatile compounds are not accumulated in animal tissues to any great extent (Shugart et al., 1990; U.S. Army Environmental Hygiene Agency, 1994). Therefore, food web exposures to these chemicals are expected to be minimal. PAHs have the potential to accumulate in lower trophic level organisms but not in higher trophic level organisms because they have mechanisms for metabolizing and excreting this class of compounds.

Carnivores may also be exposed to site-related chemicals in soil through incidental ingestion of soil while feeding, grooming, or other activities. These species may occupy the woodlands that surround Range J.

Dermal absorption of PAHs from soil is a potential exposure pathway for carnivores at Range J; however, mammals and birds are less susceptible to dermal exposures because their fur or feathers prevent skin from coming into direct contact with the soil (EPA, 1993). Dermal absorption of inorganic compounds from direct contact with soil is expected to be minimal due to the low dermal permeability of these compounds. Inhalation of volatile compounds from surface soil is a viable exposure pathway. Inhalation of constituents sorbed to soil particles and inhaled as dust is a potential exposure pathway for carnivores; however, the nearly continuous vegetative cover at Range J effectively reduces the potential for dust generation.

Typical carnivorous species expected to occur at Range J and commonly used as sentinel species in ecological risk assessment include red-tailed hawk (*Buteo jamaicensis*), black vulture (*Coragyps atratus*), and bobcat (*Lynx rufus*).

7.4.4 Complete Exposure Pathways

For exposure to occur, a complete exposure pathway must exist between the contaminant and the receptor. A complete exposure pathway requires the following four components:

- A source mechanism for contaminant release
- A transport mechanism
- A point of environmental contact
- A route of uptake at the exposure point (EPA, 1989).

If any of these four components is absent, then a pathway is generally considered incomplete. Potentially complete and incomplete exposure pathways are depicted in the SCM shown on Figure 7-1.

Ecological receptors may be exposed to constituents in soils via direct and/or secondary exposure pathways. Direct exposure pathways include soil ingestion, dermal absorption, and inhalation of volatile COPECs and COPECs adsorbed to fugitive dust. Significant exposure via dermal contact is limited to organic constituents that are lipophilic and can penetrate epidermal barriers. Mammals are less susceptible to exposure via dermal contact with soils because their fur prevents skin from coming into direct contact with soil. However, soil ingestion may occur while grooming, preening, burrowing, or consuming plants, insects, or invertebrates resident in soil.

Exposures to site-related COPECs in surface water and sediment are not likely because there are no surface water bodies associated with Range J.

Exposure via inhalation of fugitive dust is limited to contaminants present in surface soils at areas that are devoid of vegetation. The amount of vegetative cover, the inherent moisture content of the soil, and the frequency of soil disturbance also play important roles in the amount of fugitive dust generated at a particular site.

Although constituents in soils may leach into groundwater, environmental receptors generally will not come into direct contact with constituents in groundwater, since there is no direct exposure route.

Secondary exposure pathways involve constituents that are transferred through different trophic levels of the food chain and may be bioaccumulated and/or bioconcentrated. This may include constituents bioaccumulated from soil into plant tissues or into terrestrial species ingesting soils. These plants or animals may, in turn, be consumed by animals at higher trophic levels.

In general, the constituents detected in surface soil at Range J may bioaccumulate in lower trophic level organisms (i.e., terrestrial invertebrates may bioaccumulate inorganic compounds detected in soil); however, they will not bioconcentrate through the food chain. Inorganic and volatile organic compounds generally do not bioconcentrate to any great extent in either plant or animal tissues, with the exception of mercury. The only compound detected in surface soil that has a propensity to bioconcentrate is mercury. Although mercury was detected in all surface soil samples collected at Range J, it was detected in only one sample at a concentration (0.11 mg/kg) that exceeded the ESV (0.1 mg/kg) and background threshold value (BTV) (0.08 mg/kg). Therefore, bioconcentration is not expected to be a significant exposure pathway at Range J.

A summary of the feeding guilds and potentially complete exposure pathways for the terrestrial ecosystems Range J is presented in Table 7-1.

7.5 Screening-Level Risk Estimation

A screening-level estimation of potential risk can be accomplished by comparing the exposure point concentration of each detected constituent in each environmental medium to a corresponding screening-level ecological toxicity value. In order to conduct the SLERA, the following steps must be followed:

- Determine appropriate screening assessment endpoints
- Determine the ecological toxicity values that are protective of the selected assessment endpoints
- Determine the exposure point concentrations of constituents detected at the site
- Calculate screening-level hazard quotients.

These steps are summarized below.

Table 7-1

**Feeding Guilds and Exposure Pathways
for Terrestrial Ecosystems
Range J, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama**

Trophic Level	Feeding Guild	Exposure Pathways
1	Primary Producers	Direct uptake from soil
2	Terrestrial Invertebrates	Ingestion of soil Direct contact with soil
	Herbivorous Birds	Ingestion of soil Ingestion of terrestrial plants
	Herbivorous Mammals	Ingestion of soil Ingestion of terrestrial plants
3	Omnivorous Birds	Ingestion of soil Ingestion of terrestrial plants Ingestion of terrestrial invertebrates
	Omnivorous Mammals	Ingestion of soil Ingestion of terrestrial plants Ingestion of terrestrial invertebrates Ingestion of prey
	Invertivorous Birds	Ingestion of soil Ingestion of terrestrial invertebrates
	Invertivorous Mammals	Ingestion of soil Ingestion of terrestrial invertebrates
4	Carnivorous Birds (raptors)	Ingestion of soil Ingestion of prey
	Carnivorous Mammals	Ingestion of soil Ingestion of prey

7.5.1 Ecological Screening Assessment Endpoints

Most ecological risk assessments focus on population measures as endpoints, since population responses are better defined and more predictable than are community or ecosystem responses. For screening-level assessments such as this SLERA, assessment endpoints are any adverse effects on ecological receptors, where receptors are plant and animal populations and communities, habitats, and sensitive environments.

Adverse effects on populations can be inferred from measures related to impaired reproduction, growth, and survival. Adverse effects on communities can be inferred from changes in community structure or function. Adverse effects on habitats can be inferred from changes in composition and characteristics that reduce the ability of the habitat to support plant and animal populations and communities.

Due to the nature of the SLERA process, most of the screening assessment endpoints are generic in nature (e.g., protection of sediment benthic communities from adverse changes in structure or function).

The assessment endpoints for this SLERA were identified for surface soil and are summarized below:

- **Soil**
 - Protection of the terrestrial invertebrate community from adverse changes in structure and function
 - Protection of the terrestrial plant community from adverse changes in structure and function.

7.5.2 Ecological Screening Values

The ecological screening values (ESV) used in this assessment represent the most conservative values available from various literature sources and have been selected to be protective of the assessment endpoints described above. These ESVs have been developed specifically for FTMC in conjunction with EPA Region IV and are presented in the *Final Human Health and Ecological Screening Values and PAH Background Summary Report* (IT, 2000c). The ESVs used in this assessment are based on NOAELs when available. If a NOAEL-based ESV was not available for a certain COPEC, then the most health-protective value available from the scientific literature was used in this assessment.

For each environmental medium sampled at Range J (surface soil), a hierarchy has been developed which presents an orderly method for selection of ESVs. The hierarchy for selecting ESVs for surface soil is as follows:

- EPA Region IV constituent-specific ESVs
- EPA Region IV ESVs for general class of constituents
- EPA Region V ecological data quality levels
- EPA Region III Biological Technical Advisory Group values
- ESVs from Talmage et al., 1999.

7.5.3 Determination of Exposure Point Concentrations

Exposure point concentrations represent the chemical concentrations in environmental media that a receptor may contact. Since the exposure point concentration is a value that represents the most likely concentration to which receptors could be exposed, a value that reflects the central tendency of the data set is most appropriate to use for free-ranging animals that would be expected to use the site indiscriminately. Smaller, more sessile organisms with smaller home ranges may be exposed to only a portion of a site. Additionally, habitat preferences or preferential avoidance behavior may result in exposure to only portions of a given site. Therefore, a subset of the data would be most appropriate to estimate an exposure point concentration for these species. The most conservative approach is the use of the maximum detected constituent concentrations as exposure point concentrations. At the screening-level stage, the data sets are generally not robust enough for statistical analysis and the level of conservatism in the exposure estimates is high to account for uncertainties. Therefore, at the screening-level stage, the maximum detected constituent concentration in each environmental medium is used as the exposure point concentration. The use of the maximum detected constituent concentration as the exposure point concentration ensures that the exposures will not be underestimated and, therefore, constituents will not be inadvertently eliminated from further assessment.

The statistical summaries (including the exposure point concentrations) for surface soil at Range J are presented in Table 7-2.

7.5.4 Screening-Level Hazard Quotients

In order to estimate whether constituents detected in environmental media at the site have the potential to pose adverse ecological risks, screening-level hazard quotients were developed. The screening-level hazard quotients were developed via a three-step process as follows:

Table 7-2

Constituents of Potential Ecological Concern in Surface Soil^a
Range J, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 1 of 2)

Constituents	Background Threshold Value ^b (mg/kg)	Ecological Screening Value ^c (mg/kg)	Maximum Detected Conc. (mg/kg)	Minimum Detected Conc. (mg/kg)	Mean Detected Conc. (mg/kg)	Frequency of Detection	Maximum Hazard Quotient	Mean Hazard Quotient	Constituent Of Potential Ecological Concern
<u>Metals</u>									
Aluminum	1.63E+04	5.00E+01	1.18E+04	3.85E+03	8.44E+03	8 / 8	236.00	168.88	3,4
Antimony	1.99E+00	3.50E+00	1.30E+00	5.90E-01	8.59E-01	8 / 8	0.37	0.25	1,3,4
Arsenic	1.37E+01	1.00E+01	2.43E+01	7.00E+00	1.23E+01	8 / 8	2.43	1.23	5
Barium	1.24E+02	1.65E+02	3.74E+01	1.51E+01	2.34E+01	8 / 8	0.23	0.14	1,3,4
Beryllium	8.00E-01	1.10E+00	5.30E-01	2.40E-01	3.46E-01	8 / 8	0.48	0.31	1,3,4
Calcium	1.72E+03	NA	3.85E+03	3.24E+02	1.12E+03	8 / 8	ND	ND	2,5
Chromium	3.70E+01	4.00E-01	5.17E+01	1.72E+01	2.62E+01	8 / 8	129.25	65.47	5
Cobalt	1.52E+01	2.00E+01	6.60E+00	2.00E+00	3.68E+00	8 / 8	0.33	0.18	1,3
Copper	1.27E+01	4.00E+01	2.46E+01	5.80E+00	1.15E+01	8 / 8	0.62	0.29	1,5
Iron	3.42E+04	2.00E+02	3.82E+04	1.01E+04	2.13E+04	8 / 8	191.00	106.69	5
Lead	4.01E+01	5.00E+01	1.03E+01	6.70E+00	8.84E+00	8 / 8	0.21	0.18	1,3,4
Magnesium	1.03E+03	4.40E+05	2.14E+03	1.28E+02	4.37E+02	8 / 8	0.0049	0.0010	1,2,4
Manganese	1.58E+03	1.00E+02	2.16E+02	5.32E+01	1.22E+02	8 / 8	2.16	1.22	3,4
Mercury	8.00E-02	1.00E-01	1.10E-01	1.90E-02	5.43E-02	8 / 8	1.10	0.54	4
Nickel	1.03E+01	3.00E+01	1.11E+01	3.20E+00	6.06E+00	8 / 8	0.37	0.20	1,5
Potassium	8.00E+02	NA	2.24E+02	5.70E+01	1.40E+02	8 / 8	ND	ND	2,3,4
Selenium	4.80E-01	8.10E-01	7.40E-01	4.30E-01	3.84E-01	3 / 8	0.91	0.47	1,4
Vanadium	5.88E+01	2.00E+00	7.43E+01	2.08E+01	4.31E+01	8 / 8	37.15	21.53	5
Zinc	4.06E+01	5.00E+01	6.95E+01	1.71E+01	3.70E+01	8 / 8	1.39	0.74	5
<u>Semivolatile Organic Compounds</u>									
bis(2-Ethylhexyl)phthalat	NA	9.26E-01	6.40E-02	6.10E-02	4.39E-01	2 / 8	0.07	0.47	1
<u>Volatile Organic Compounds</u>									
1,2,4-Trimethylbenzene	NA	1.00E-01	2.40E-03	2.40E-03	4.40E-03	1 / 32	0.024	0.044	1
1,2-Dimethylbenzene	NA	1.00E-01	7.90E-04	7.90E-04	4.35E-03	1 / 32	0.008	0.043	1
2-Butanone	NA	8.96E+01	2.00E-02	3.60E-03	1.10E-02	7 / 14	0.00022	0.00012	1
2-Hexanone	NA	1.26E+01	8.20E-03	8.20E-03	1.78E-02	1 / 31	0.00065	0.00142	1
Acetone	NA	2.50E+00	2.10E+01	6.90E-03	1.21E+00	20 / 20	8.40	0.48	YES ⁷
Bromomethane	NA	NA	2.30E-02	2.30E-02	1.05E-02	1 / 9	ND	ND	6

Table 7-2

Constituents of Potential Ecological Concern in Surface Soil^a
Range J, Parcel 202(7)
Fort McClellan, Calhoun County, Alabama

(Page 2 of 2)

Constituents	Background Threshold Value ^b (mg/kg)	Ecological Screening Value ^c (mg/kg)	Maximum Detected Conc. (mg/kg)	Minimum Detected Conc. (mg/kg)	Mean Detected Conc. (mg/kg)	Frequency of Detection	Maximum Hazard Quotient	Mean Hazard Quotient	Constituent Of Potential Ecological Concern
Cumene	NA	NA	5.70E-03	5.70E-03	4.50E-03	1 / 32	ND	ND	6
Methylene chloride	NA	1.00E-01	3.80E-02	3.80E-02	3.80E-02	1 / 1	0.38	0.38	1
Naphthalene	NA	1.00E-01	1.70E-02	8.80E-03	4.66E-03	2 / 32	0.17	0.05	1
p-Cymene	NA	NA	6.30E-02	4.30E-03	7.72E-03	5 / 32	ND	ND	6
Toluene	NA	5.00E-02	1.80E-03	1.30E-03	4.33E-03	2 / 32	0.036	0.087	1
Trichlorofluoromethane	NA	1.00E-01	3.30E-03	1.30E-03	9.37E-03	3 / 24	0.033	0.094	1
m,p-Xylenes	NA	5.00E-02	1.60E-03	1.60E-03	4.37E-03	1 / 32	0.032	0.087	1

^aSurface soil at Range J is defined as the interval from 0 to 1 feet below ground surface.

^bBackground threshold value is two times (2x) the arithmetic mean of background metals (Science Applications International Corporation, 1998).

^cEcological Screening Values (ESV) are presented in *Final Human Health and Ecological Screening Values and PAH Background Summary Report* (IT, 2000c).

NA - Not available. ND - Not determined.

Rationale for exclusion as a COPEC:

- 1 - Maximum detected concentration is less than ESV
- 2 - Essential macronutrient, only toxic at extremely high concentrations (i.e. 10 times naturally occurring background concentrations).
- 3 - Maximum detected concentration is less than the background threshold value (BTV).
- 4 - Slippage Test and Wilcoxon Rank Sum Test indicate the concentration of this constituent is statistically similar to background concentrations.
- 5 - Geochemical evaluation of the data indicate that this constituent is naturally occurring.
- 6 - No ESV available; however, maximum detected concentration of this constituent is less than ESV for similar compounds.
- 7 - Additional lines of evidence indicate that this constituent may not be a COPEC (see text).

- Comparison to ESVs
- Identification of essential macronutrients
- Comparison to naturally occurring background concentrations.

Constituents that were detected in environmental media at Range J were evaluated against the ESVs by calculating a screening-level hazard quotient (HQ_{screen}) for each constituent in each environmental medium. An HQ_{screen} was calculated by dividing the maximum detected constituent concentration in each environmental medium by its corresponding ESV as follows:

$$HQ_{\text{screen}} = \frac{MDCC}{ESV}$$

where:

HQ_{screen} = screening-level hazard quotient
 MDCC = maximum detected constituent concentration
 ESV = ecological screening value.

A calculated HQ_{screen} value of one indicates that the MDCC is equal to the chemical's conservative ESV and is interpreted in this assessment as a constituent that does not pose the potential for adverse ecological risk. An HQ_{screen} value less than one indicates that the MDCC is less than the conservative ESV and that the chemical is not likely to pose adverse ecological hazards to most receptors. Conversely, an HQ_{screen} value greater than one indicates that the MDCC is greater than the ESV and that the chemical might pose adverse ecological hazards to one or more receptors.

In order to better understand the potential risks posed by chemical constituents at Range J, a mean hazard quotient was also calculated by comparing the arithmetic mean constituent concentration in surface soil to the corresponding ESV. The calculated screening-level hazard quotients for surface soil at Range J are presented in Table 7-2.

The EPA recognizes several constituents in abiotic media that are necessary to maintain normal function in many organisms. These essential macronutrients are iron, magnesium, calcium, potassium, and sodium (EPA, 1989). Most organisms have mechanisms designed to regulate nutrient fluxes within their systems; therefore, these nutrients are generally toxic only at very high concentrations. Although iron is an essential nutrient and is regulated within many organisms, it may become increasingly bioavailable at lower soil pH values, thus increasing its

potential to elicit adverse affects. Therefore, iron was not evaluated as an essential nutrient in this SLERA. Essential macronutrients were only considered COPECs if they were present in site samples at concentrations ten times the naturally occurring background concentration.

The comparison of detected constituent concentrations with naturally occurring constituent concentrations was conducted via a three-tier process outlined in the technical memorandum “Selecting Site-Related Chemicals for Human Health and Ecological Risk Assessments for FTMC: Revision 2” (Shaw, 2003). The first tier of the background comparison process was a comparison of the maximum detected constituent concentration to the BTV. A study of the natural geochemical composition associated with FTMC (SAIC, 1998) determined the mean concentrations of 24 metals in surface soil, surface water, sediment, and groundwater samples collected from presumably unimpacted areas. Per agreement with EPA Region 4, the BTV for each metal was calculated as two times the mean background concentration for that metal. The BTV for each metal was used to represent the upper boundary of the range of natural background concentrations expected at FTMC and was used as the basis for evaluating metal concentrations measured in site samples. Site sample metal concentrations less than or equal to the corresponding BTV represent the natural geochemical composition of media at FTMC, and not contamination associated with site activity. Site sample metal concentrations greater than the corresponding BTV require further background assessment.

If maximum constituent concentrations were greater than the BTV, then the second tier of the background comparison was employed. Tier two of the background comparison consists of statistical comparisons of the site data to background data using the Slippage Test and the Wilcoxon Rank Sum Test. If the site data failed either the Slippage Test or the Wilcoxon Rank Sum Test, then the site data were subjected to a geochemical evaluation to determine whether concentrations of inorganic compounds are naturally occurring or are elevated due to contamination (tier 3). The three-tier background comparison process is described in detail in Appendix K of this report.

Thus, the first step in determining screening-level hazard quotients was a comparison of maximum detected constituent concentrations to appropriate ESVs. Constituents with HQ_{screen} values less than one were considered to pose insignificant ecological risk and were eliminated from further consideration. Constituents with HQ_{screen} values greater than one were eliminated from further consideration if they were macronutrients and their detected concentrations were less than ten times naturally occurring levels. Those constituents that had HQ_{screen} values greater one and were not considered macronutrients were then compared to background using the three-

tier background screening process. If constituent concentrations were determined to be less than their naturally occurring background concentrations, then a risk management decision could result in eliminating these constituents from further assessment.

7.6 Identification of Constituents of Potential Ecological Concern

A constituent was identified as a COPEC if the following conditions were met:

- The maximum detected constituent concentration exceeded the ESV
- The maximum detected constituent concentration was 10 times the BTV if the constituent was identified as a macronutrient
- Constituent concentrations were determined to be greater than naturally occurring levels based on the three-tier background screening process.

If a constituent in a given environmental medium did not meet these conditions, then it was not considered a COPEC at Range J and was not considered for further assessment. If a constituent met these conditions, then it was considered a COPEC. Identification of a constituent as a COPEC indicates that further assessment of that particular constituent in a given environmental medium may be appropriate. It does not imply that a particular constituent poses risk to ecological receptors.

The COPECs that have been identified for surface soil at Range J are presented in Table 7-2. COPECs were not identified in surface water or sediment because there are no surface water bodies associated with Range J.

In order to focus future ecological assessment efforts on the constituents that are the most prevalent at Range J and have the greatest potential to pose ecological risk, additional lines of evidence were assessed. Additional lines of evidence are sometimes useful in determining whether a certain constituent is in fact site-related and a COPEC. Some of the additional lines of evidence used in the process of identifying COPECs include: 1) frequency of detection, 2) magnitude of the HQ_{screen} value, 3) spatial distribution, 4) alternative ESVs, and 5) association of the chemical with known Army activities. These additional lines of evidence were used to further define the COPECs at Range J and are discussed below.

Inorganic constituents that exceeded their respective ESVs and BTVs in surface soil at Range J include the following: arsenic, chromium, iron, mercury, vanadium, and zinc. In order to more

closely scrutinize the relationship between site-related chemicals and naturally occurring soil constituents, an integrated statistical and geochemical evaluation was conducted (tier 3 of the three-tiered background screening process). The methodology and results of this comparison of site and background data are provided in Appendix K. Statistical evaluation of the data for mercury indicates that mercury in surface soil at Range J is naturally occurring. Geochemical evaluation indicates that concentrations of arsenic, chromium, iron, vanadium, and zinc are most likely the result of the preferential enrichment of samples with iron oxide minerals, which naturally concentrate trace elements. These results indicate that these inorganic constituents of soil are naturally occurring and are not the result of site-related activities. Therefore, these inorganic constituents are not considered COPECs in surface soil at Range J.

Arsenic. Arsenic was detected in three of eight surface soil samples at concentrations that exceeded the ESV and BTV. The calculated HQ_{screen} value for arsenic was 2.43. If an alternative ESV of 60 mg/kg is considered (based on earthworm toxicity, Efroymson et al., 1997), none of the detected concentrations of arsenic exceed the alternative ESV. Additionally, geochemical evaluation of arsenic in site samples and background samples indicates that the detected arsenic concentrations in soil from Range J are naturally occurring. Based on the relatively low HQ_{screen} value, the fact that all detected arsenic concentrations are less than the alternative ESV, and the results of geochemical evaluation that determined that the detected arsenic concentrations are naturally occurring, arsenic was not considered a COPEC in surface soil at Range J.

Chromium. Chromium was detected in two of eight surface soil samples at concentrations that exceeded the ESV and BTV. The calculated HQ_{screen} value for chromium was 129.25. However, the ESV is based on the toxicity of hexavalent chromium, the more toxic form of chromium. If an alternative ESV of 32 mg/kg is considered (based on earthworm toxicity to Cr^{+3} , Efroymson et al., 1997), the calculated HQ_{screen} value is 1.6. It is realistic to assume that a large portion of the detected chromium in soil is in the trivalent form, as opposed to the hexavalent form; therefore, the alternative ESV may provide a better assessment of soil conditions at Range J. Additionally, geochemical evaluation of chromium in site samples and background samples indicates that the detected chromium concentrations in soil from Range J are naturally occurring. Based on the relatively low HQ_{screen} value when calculated using the alternative ESV, the relatively low frequency of detection at concentrations that exceed the ESV and BTV, and the fact that geochemical evaluation has determined that the detected chromium concentrations are naturally occurring, chromium was not considered a COPEC in surface soil at Range J.

Iron. Iron was detected in one of eight samples at a concentration that exceeded the ESV and BTV. Iron is also considered an essential macronutrient for many organisms, meaning it is essential to maintain normal bodily functions and concentrations are easily regulated by many organisms. Additionally, geochemical evaluation of iron in site samples and background samples indicates that the detected iron concentrations in soil from Range J are naturally occurring. Based on the low frequency of detection at concentrations greater than the ESV and BTV, the fact that iron is an essential macro-nutrient for many organisms, and the results of geochemical evaluation that determined that iron in soil at Range J is naturally occurring, iron was not considered a COPEC in surface soil at Range J.

Mercury. Mercury was detected in one of eight surface soil samples at a concentration that exceeded the ESV and BTV. The calculated HQ_{screen} value for mercury was 1.1. Statistical analysis of mercury in site samples and background samples indicates that the detected concentrations of mercury in soil from Range J are naturally occurring. Therefore, based on the low frequency of detection at concentrations that exceed the ESV and BTV, the low HQ_{screen} value, and the fact that statistical analysis indicates that mercury in surface soil at Range J is naturally occurring, mercury was not identified as a COPEC in surface soil at Range J.

Vanadium. Vanadium was detected in one of eight surface soil samples at a concentration that exceeded the ESV and BTV. The calculated HQ_{screen} value for vanadium was 37.15. Geochemical evaluation of vanadium in site samples and background samples indicates that the detected vanadium concentrations in surface soil from Range J are naturally occurring. Therefore, based on the low frequency of detection at concentrations greater than the ESV and BTV and the fact that geochemical evaluation has determined that the detected concentrations of vanadium are naturally occurring, vanadium was not identified as a COPEC in surface soil at Range J.

Zinc. Zinc was detected in three of eight samples at concentrations that exceeded the ESV and BTV. The calculated HQ_{screen} value for zinc was 1.4. If an alternative ESV of 100 mg/kg is considered (based on earthworm toxicity, Efroymson et al., 1997), none of the detected concentrations of zinc exceed the alternative ESV. Additionally, geochemical evaluation of zinc in site samples and background samples indicates that the detected zinc concentrations in surface soil from Range J are naturally occurring. Therefore, based on the low frequency of detection at concentrations greater than the ESV and BTV, the relatively low HQ_{screen} value, the fact that all detected zinc concentrations are less than the alternative ESV, and the results of geochemical

evaluation that determined that the detected zinc concentrations are naturally occurring, zinc was not considered a COPEC in surface soil at Range J.

VOCs. Acetone, bromomethane, cumene, and p-cymene were detected in surface soil samples from Range J. One surface soil sample out of 20 exhibited an elevated concentration of acetone. The calculated HQ_{screen} value for acetone was 8.4. The arithmetic mean detected acetone concentration was 1.2 mg/kg, which is less than the ESV. The source of acetone at Range J is unclear. However, it is likely that the acetone is an artifact from the use of isopropyl alcohol as a solvent in equipment decontamination during the sampling process. Isopropyl alcohol is known to degrade to acetone under oxidative conditions. Based on the low frequency of detection at elevated concentrations, the relatively low magnitude of the calculated HQ_{screen} value, and the potential association of the detected concentration with decontamination procedures during sampling, acetone was not considered a COPEC in surface soil at Range J.

No ESVs exist for bromomethane, cumene, or p-cymene in surface soil. Therefore, no definitive statement regarding their toxicity to ecological receptors can be made. However, the detected concentrations of these three VOCs are significantly less than the ESVs for other similar VOCs. Therefore, it is reasonable to conclude that bromomethane, cumene, and p-cymene are present in soil samples at concentrations that most likely would not pose significant ecological risk. Additionally, these three VOCs were infrequently detected in soil samples from Range J (bromomethane: 1 of 9 samples, cumene: 1 of 32 samples, and p-cymene: 5 of 32 samples). Based on the infrequency of detection and the fact that the detected concentrations were less than the ESVs for other similar VOCs, bromomethane, cumene, and p-cymene were not considered COPECs in soil at Range J.

7.7 Uncertainty Analysis

Uncertainties are inherent in any risk assessment, and even more so in a SLERA, due to the nature of the assessment process and the assumptions used in the process. A number of the major areas of uncertainty in this assessment are presented below.

An area of uncertainty that is inherent in a SLERA is the use of the maximum detected constituent concentration as the exposure point concentration for all receptors in a given medium. Most receptors have a home range large enough to preclude individuals from being exposed to the maximum constituent concentration for their entire lifetimes. Therefore, the actual exposure point concentration of a given constituent for most receptor species would be less than the maximum detected concentration. The use of the maximum detected constituent

concentrations as the exposure point concentrations for all receptors results in an overestimation of exposure for many receptors.

Additionally, there is no consideration given to the bioavailability of COPECs to different organisms. In this SLERA it is assumed that all constituents are 100 percent bioavailable to all receptor organisms. It is known that many constituents (particularly inorganic compounds) have significantly lower bioavailabilities (e.g., 1 to 10 percent for some inorganics in soil) than the 100 percent that was assumed in this assessment. This assumption has the potential to greatly overestimate exposures to certain COPECs.

Several COPECs (e.g., bromomethane, cumene, and p-cymene) do not have ESVs. The lack of toxicity data for certain COPECs makes it impossible to determine the potential for ecological risk posed by those constituents. Risks may be under- or overestimated due to this uncertainty.

The ESVs used in this assessment are all the most conservative values from the scientific literature, and many are based on the most sensitive endpoint (NOAEL values) for the most sensitive species tested. A less sensitive endpoint that is still protective of the ecological populations or communities of interest may be the LOAEL or some other endpoint. The use of NOAEL-based ESVs may overestimate potential for risks from certain COPECs. Additionally, certain ESVs may not be applicable to conditions at Range J. For instance, the soil ESVs do not take into account site-specific conditions at Range J and thus introduce a potentially significant level of uncertainty into the assessment.

The source of acetone at Range J is unclear. However, it is likely that the acetone is an artifact from the use of isopropyl alcohol as a solvent in equipment decontamination during the sampling process. Associated quality assurance equipment rinsate blank sample data also show acetone at trace level concentrations, which may indicate that the sampling equipment was contributing to the acetone concentrations in the field samples. Because the equipment rinsate blanks were collected once per week and the individual field samples were collected daily, their correlation is not exact, but the relationship is implied. Isopropyl alcohol is known to degrade to acetone under oxidative conditions, which may explain the presence of acetone in the rinsate samples.

It is important to note that the chromium ESV is based on toxicity studies using Cr^{+6} , which is more mobile and generally more toxic than Cr^{+3} . Measured chromium concentrations in surface soil are total chromium values. It is unknown what portion, if any, of the measured chromium in surface soil is in the hexavalent form. Because it is likely that only a portion of the measured

chromium in surface soil is in the hexavalent form, the ESV and subsequent HQ_{screen} are highly conservative.

Another area of uncertainty is the lack of consideration of synergisms and/or antagonisms between COPECs. Although it is widely accepted that synergisms and antagonisms occur between certain constituents under certain conditions, the SLERA process does not provide methods for assessing these potential synergisms/antagonisms.

7.8 Summary and Conclusions

The potential for ecological risks at Range J was determined through a SLERA. This ecological screening process consisted of a characterization of the ecological setting at Range J, development of an SCM, a description of the fate and transport of constituents detected in various environmental media, a description of the ecotoxicity of the various constituents detected at Range J, a description of the ecological receptors, a description of the complete exposure pathways, calculation of screening-level hazard quotients, and a description of the uncertainties within the process.

7.8.1 SLERA Summary

The constituents in surface soil at Range J that exhibited maximum concentrations that exceeded their respective ESVs and BTVs were the following: arsenic, chromium, iron, mercury, vanadium, zinc, and acetone. These seven constituents exhibited maximum hazard quotients (HQ) ranging from 1.1 to 191. Hazard quotients for bromomethane, cumene, and p-cymene could not be calculated because there were no ESVs available for these constituents.

A more rigorous comparison of site and background data was performed for inorganic constituents in soil. This integrated statistical and geochemical evaluation indicated that detected concentrations of arsenic, chromium, iron, mercury, vanadium, and zinc are most likely associated with iron oxide minerals, which naturally concentrate specific trace elements. This analysis indicated that these inorganic constituents are naturally occurring and are not present as a result of site-related activity. Based on the statistical and geochemical background evaluation and other lines of evidence, none of the detected metals were identified as COPECs in surface soil at Range J.

Additional lines of evidence also indicated that the organic constituents (acetone, bromomethane, cumene, and p-cymene) should not be considered COPECs in surface soil at Range J.

7.8.2 Conclusions of SLERA

The SLERA at Range J determined that the maximum detected concentrations of several inorganic constituents and acetone in surface soil exceeded their respective ESVs and BTVs. Bromomethane, cumene, and p-cymene were also detected in surface soil samples. Statistical and geochemical evaluation of the site and background data indicated that the identified inorganics were naturally occurring and should not be considered COPECs in surface soil. Additional lines of evidence also indicated that acetone, bromomethane, cumene, and p-cymene should not be considered COPECs in surface soil at Range J.

Therefore, based on the conservative assessment techniques used in the SLERA process and additional lines of evidence, it could be concluded that none of the constituents in surface soil present risks to terrestrial ecosystems at Fort McClellan. Therefore, further ecological assessment is not warranted at Range J.

8.0 Summary, Conclusions, and Recommendations

This chapter summarizes the results of the RI at Range J and presents the major conclusions. In addition, recommendations are made regarding further investigation at this site.

8.1 Summary and Conclusions

8.1.1 Geophysical Survey

A surface geophysical survey using magnetic and EM methods was conducted at the site. The objective of the survey was to locate buried metal debris and to delineate potential drum disposal areas. No geophysical anomalies were identified within the geophysical survey area. A source location has not been specifically determined.

8.1.2 Geological and Hydrogeological Data

Based on data collected during the drilling of 28 monitoring wells, the geology at Range J is characterized by 60 to 90 feet of residuum overlying fractured dolomite of the Cambro-Ordovician age Knox Group. The residuum consists of cherty, clayey sand to sandy clay. The dolomite bedrock is highly fractured and vuggy. Voids present in the dolomite range in size from 0.4 to 30.5 feet. A transitional zone of sandy, weathered dolomite separates the residuum and the bedrock. The top of the bedrock approximately corresponds to present-day topography.

Groundwater elevation data collected from periods of high precipitation (June) and low precipitation (October) show an overall westward flow direction of groundwater. Horizontal hydraulic gradients are very low, with less than one foot of potentiometric head across the site in both residuum and bedrock. Hydraulic conductivity values calculated from slug tests for residuum wells yielded a geometric mean value of 3.04 ft/day and for bedrock wells a value of 6.52 ft/day. Average linear groundwater flow velocity was calculated to be 0.01581 ft/day for the residuum and 0.10562 ft/day for the bedrock.

8.1.3 Surface and Subsurface Soil Contaminant Distribution

Surface and subsurface soil samples were collected during the installation of the monitoring wells. Metals were detected above SSSLs and ESVs in surface soil samples and above SSSLs in subsurface samples. An integrated statistical and geochemical evaluation of these metals indicated that the metals are naturally occurring. A similar conclusion was reached for metals detected in subsurface soils above SSSLs.

VOC and SVOC concentrations in surface and subsurface soils were below SSSLs and ESVs, except for acetone in one surface soil sample. The acetone result was below its SSSL but exceeded its ESV. Although carbon tetrachloride and chloroform were detected in approximately 20 percent of the subsurface soil samples, the concentrations were well below SSSLs.

8.1.4 Groundwater Contaminant Distribution

Based on the soil and groundwater data collected at the site, the most likely fate and transport pathway is the leaching of organic contaminants within subsurface soils and movement through the residuum into the bedrock aquifer system.

A few metals were detected in groundwater samples at concentrations exceeding SSSLs and background. An integrated statistical and geochemical evaluation of groundwater data concluded that these metals are probably naturally occurring.

The concentrations of seven organic compounds detected in groundwater samples exceeded SSSLs. The compounds were 1,1,2,2-PCA 1,2-DCA, benzene, carbon tetrachloride, chloroform, PCE, and TCE. The horizontal and vertical extent of these contaminants in groundwater has been defined.

Isoconcentration maps of total VOCs, chlorinated VOCs, and carbon tetrachloride show no clear relationship between contaminant plume migration and groundwater flow direction. Linear or advective velocities calculated for transport are too low to adequately account for the contaminant distribution. Transport mechanisms such as dispersion and diffusion in the residuum and fracture and solution porosity in the bedrock may be the dominant mechanisms for flow.

8.1.5 Streamlined Human Health Risk Assessment

The SRA identified six VOCs as COCs for the resident exposed to groundwater: 1,1,2,2-PCA, 1,2-DCA, benzene, carbon tetrachloride, chloroform, and PCE. For the National Guardsperson the SRA identified four VOCs as COCs in groundwater: 1,2-DCA, benzene, carbon tetrachloride, and chloroform. The SRA concluded that 1,2-DCA, benzene, and carbon tetrachloride are present in groundwater at levels that present an unacceptable threat to human health. Of these compounds, the primary risk driver for groundwater at Range J is carbon tetrachloride. No chemicals were identified as COPCs in soils.

8.1.6 Screening-Level Ecological Risk Assessment

The SLERA identified six metals (arsenic, chromium, iron, mercury, vanadium, and zinc) and four VOCs (acetone, bromomethane, cumene, and p-cymene) as COPECs in surface soil. The statistical and geochemical evaluations of the metals results, however, indicated that they are all naturally occurring. The VOCs were ultimately excluded as COPECs based on additional lines of evidence (e.g., frequency of detection, relative magnitude of exceedance, and comparison to ESVs for similar compounds). The SLERA concluded that none of the COPECs in surface soil present an unacceptable risk to terrestrial ecosystems at Range J.

8.2 Recommendations

Based on the summary and conclusions presented above, no further actions are warranted with respect to defining the extent of contamination in soils. With respect to the groundwater contamination, it is recommended that an interim removal action be performed or that a focused feasibility study be conducted to screen remedial action technologies and process options for groundwater remedial alternatives.

9.0 References

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ATTACHMENT 1

LIST OF ABBREVIATIONS AND ACRONYMS

List of Abbreviations and Acronyms

2,4-D	2,4-dichlorophenoxyacetic acid	AUF	area use factor	CESAS	Corps of Engineers South Atlantic Savannah
2,4,5-T	2,4,5-trichlorophenoxyacetic acid	AWARE	Associated Water and Air Resources Engineers, Inc.	CF	conversion factor
2,4,5-TP	2,4,5-trichlorophenoxypropionic acid	AWQC	ambient water quality criteria	CFC	chlorofluorocarbon
3D	3D International Environmental Group	AWWSB	Anniston Water Works and Sewer Board	CFDP	Center for Domestic Preparedness
AB	ambient blank	‘B’	Analyte detected in laboratory or field blank at concentration greater than the reporting limit (and greater than zero)	CFR	Code of Federal Regulations
AbB3	Anniston gravelly clay loam, 2 to 6 percent slopes, severely eroded	BCF	blank correction factor; bioconcentration factor	CG	phosgene (carbonyl chloride)
AbC3	Anniston gravelly clay loam, 6 to 10 percent slopes, severely eroded	BCT	BRAC Cleanup Team	CGI	combustible gas indicator
AbD3	Anniston and Allen gravelly clay loams, 10 to 15 percent slopes, eroded	BERA	baseline ecological risk assessment	ch	inorganic clays of high plasticity
Abs	skin absorption	BEHP	bis(2-ethylhexyl)phthalate	CHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
ABS	dermal absorption factor	BFB	bromofluorobenzene	CIH	Certified Industrial Hygienist
AC	hydrogen cyanide	BFE	base flood elevation	CK	cyanogen chloride
ACAD	AutoCadd	BG	Bacillus globigii	cl	inorganic clays of low to medium plasticity
AcB2	Anniston and Allen gravelly loams, 2 to 6 percent slopes, eroded	BGR	Bains Gap Road	Cl	chlorinated
AcC2	Anniston and Allen gravelly loams, 6 to 10 percent slopes, eroded	bgs	below ground surface	CLP	Contract Laboratory Program
AcD2	Anniston and Allen gravelly loams, 10 to 15 percent slopes, eroded	BHC	hexachlorocyclohexane	cm	centimeter
AcE2	Anniston and Allen gravelly loams, 15 to 25 percent slopes, eroded	BHHRA	baseline human health risk assessment	CN	chloroacetophenone
ACGIH	American Conference of Governmental Industrial Hygienists	BIRTC	Branch Immaterial Replacement Training Center	CNB	chloroacetophenone, benzene, and carbon tetrachloride
AdE	Anniston and Allen stony loam, 10 to 25 percent slope	bkg	background	CNS	chloroacetophenone, chloropicrin, and chloroform
ADEM	Alabama Department of Environmental Management	bls	below land surface	CO	carbon monoxide
ADPH	Alabama Department of Public Health	BOD	biological oxygen demand	CO ₂	carbon dioxide
AEC	U.S. Army Environmental Center	Bp	soil-to-plant biotransfer factors	Co-60	cobalt-60
AEDA	ammunition, explosives, and other dangerous articles	BRAC	Base Realignment and Closure	CoA	Code of Alabama
AEL	airborne exposure limit	Braun	Braun Intertec Corporation	COC	chain of custody; chemical of concern
AET	adverse effect threshold	BSAF	biota-to-sediment accumulation factors	COE	Corps of Engineers
AF	soil-to-skin adherence factor	BSC	background screening criterion	Con	skin or eye contact
AHA	ammunition holding area	BTAG	Biological Technical Assistance Group	COPC	chemical of potential concern
AL	Alabama	BTEX	benzene, toluene, ethyl benzene, and xylenes	COPEC	constituent of potential ecological concern
ALARNG	Alabama Army National Guard	BTOC	below top of casing	CPSS	chemicals present in site samples
ALAD	δ-aminolevulinic acid dehydratase	BTV	background threshold value	CQCSM	Contract Quality Control System Manager
ALDOT	Alabama Department of Transportation	BW	biological warfare; body weight	CRDL	contract-required detection limit
amb.	amber	BZ	breathing zone; 3-quinuclidinyl benzilate	CRL	certified reporting limit
amsl	above mean sea level	C	ceiling limit value	CRQL	contract-required quantitation limit
ANAD	Anniston Army Depot	Ca	carcinogen	CRZ	contamination reduction zone
AOC	area of concern	CaCO ₃	calcium carbonate	Cs-137	cesium-137
AP	armor piercing	CAA	Clean Air Act	CS	ortho-chlorobenzylidene-malononitrile
APEC	areas of potential ecological concern	CAB	chemical warfare agent breakdown products	CSEM	conceptual site exposure model
APT	armor-piercing tracer	CACM	Chemical Agent Contaminated Media	CSM	conceptual site model
AR	analysis request	CAMU	corrective action management unit	CT	central tendency
ARAR	applicable or relevant and appropriate requirement	CBR	chemical, biological, and radiological	ctr.	container
AREE	area requiring environmental evaluation	CCAL	continuing calibration	CWA	chemical warfare agent; Clean Water Act
AS/SVE	air sparging/soil vapor extraction	CCB	continuing calibration blank	CWM	chemical warfare material; clear, wide mouth
ASP	Ammunition Supply Point	CCV	continuing calibration verification	CX	dichloroformoxime
ASR	Archives Search Report	CD	compact disc	‘D’	duplicate; dilution
AST	aboveground storage tank	CDTF	Chemical Defense Training Facility	D&I	detection and identification
ASTM	American Society for Testing and Materials	CEHNC	U.S. Army Engineering and Support Center, Huntsville	DAAMS	depot area agent monitoring station
AT	averaging time	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	DAF	dilution-attenuation factor
ATSDR	Agency for Toxic Substances and Disease Registry	CERFA	Community Environmental Response Facilitation Act	DANC	decontamination agent, non-corrosive
ATV	all-terrain vehicle			°C	degrees Celsius

List of Abbreviations and Acronyms (Continued)

°F	degrees Fahrenheit	EPIC	Environmental Photographic Interpretation Center	g/m ³	gram per cubic meter
DCA	dichloroethane	EPRI	Electrical Power Research Institute	G-856	Geometrics, Inc. G-856 magnetometer
DCE	dichloroethene	ER	equipment rinsate	G-858G	Geometrics, Inc. G-858G magnetic gradiometer
DDD	dichlorodiphenyldichloroethane	ERA	ecological risk assessment	GAF	gastrointestinal absorption factor
DDE	dichlorodiphenyldichloroethene	ER-L	effects range-low	gal	gallon
DDT	dichlorodiphenyltrichloroethane	ER-M	effects range-medium	gal/min	gallons per minute
DEH	Directorate of Engineering and Housing	ESE	Environmental Science and Engineering, Inc.	GB	sarin (isopropyl methylphosphonofluoridate)
DEP	depositional soil	ESMP	Endangered Species Management Plan	gc	clay gravels; gravel-sand-clay mixtures
DFTPP	decafluorotriphenylphosphine	ESN	Environmental Services Network, Inc.	GC	gas chromatograph
DI	deionized	ESV	ecological screening value	GCL	geosynthetic clay liner
DID	data item description	ET	exposure time	GC/MS	gas chromatograph/mass spectrometer
DIMP	di-isopropylmethylphosphonate	EU	exposure unit	GCR	geosynthetic clay liner
DM	dry matter; adamsite	Exp.	explosives	GFAA	graphite furnace atomic absorption
DMBA	dimethylbenz(a)anthracene	E-W	east to west	GIS	Geographic Information System
DMMP	dimethylmethylphosphonate	EZ	exclusion zone	gm	silty gravels; gravel-sand-silt mixtures
DO	dissolved oxygen	FAR	Federal Acquisition Regulations	gp	poorly graded gravels; gravel-sand mixtures
DOD	U.S. Department of Defense	FB	field blank	gpm	gallons per minute
DOJ	U.S. Department of Justice	FD	field duplicate	GPR	ground-penetrating radar
DOT	U.S. Department of Transportation	FDC	Former Decontamination Complex	GPS	global positioning system
DP	direct-push	FDA	U.S. Food and Drug Administration	GRA	general response action
DPDO	Defense Property Disposal Office	Fe ⁺³	ferric iron	GS	ground scar
DPT	direct-push technology	Fe ⁺²	ferrous iron	GSA	General Services Administration; Geologic Survey of Alabama
DQO	data quality objective	FedEx	Federal Express, Inc.	GSBP	Ground Scar Boiler Plant
DRMO	Defense Reutilization and Marketing Office	FEMA	Federal Emergency Management Agency	GSSI	Geophysical Survey Systems, Inc.
DRO	diesel range organics	FFCA	Federal Facilities Compliance Act	GST	ground stain
DS	deep (subsurface) soil	FFE	field flame expedient	GW	groundwater
DS2	Decontamination Solution Number 2	FFS	focused feasibility study	gw	well-graded gravels; gravel-sand mixtures
DSERTS	Defense Site Environmental Restoration Tracking System	FI	fraction of exposure	H&S	health and safety
DWEL	drinking water equivalent level	Fil	filtered	HA	hand auger
E&E	Ecology and Environment, Inc.	Flt	filtered	HC	mixture of hexachloroethane, aluminum powder, and zinc oxide (smoke producer)
EB	equipment blank	FMDC	Fort McClellan Development Commission	HCl	hydrochloric acid
EBS	environmental baseline survey	FML	flexible membrane liner	HD	distilled mustard (bis-[dichloroethyl]sulfide)
EC ₅₀	effects concentration for 50 percent of a population	f _{oc}	fraction organic carbon	HDPE	high-density polyethylene
ECBC	Edgewood Chemical Biological Center	FOMRA	Former Ordnance Motor Repair Area	HE	high explosive
ED	exposure duration	FOST	Finding of Suitability to Transfer	HEAST	Health Effects Assessment Summary Tables
EDD	electronic data deliverable	Foster Wheeler	Foster Wheeler Environmental Corporation	Herb.	herbicides
EF	exposure frequency	FR	Federal Register	HHRA	human health risk assessment
EDQL	ecological data quality level	Frtn	fraction	HI	hazard index
EE/CA	engineering evaluation and cost analysis	FS	field split; feasibility study	H ₂ O ₂	hydrogen peroxide
Elev.	elevation	FSP	field sampling plan	HPLC	high-performance liquid chromatography
EM	electromagnetic	ft	feet	HNO ₃	nitric acid
EMI	Environmental Management Inc.	ft/day	feet per day	HQ	hazard quotient
EM31	Geonics Limited EM31 Terrain Conductivity Meter	ft/ft	feet per foot	HQ _{screen}	screening-level hazard quotient
EM61	Geonics Limited EM61 High-Resolution Metal Detector	ft/yr	feet per year	hr	hour
EOD	explosive ordnance disposal	FTA	Fire Training Area	HRC	hydrogen releasing compound
EODT	explosive ordnance disposal team	FTMC	Fort McClellan	HSA	hollow-stem auger
EPA	U.S. Environmental Protection Agency	FTRRA	FTMC Reuse & Redevelopment Authority	HTRW	hazardous, toxic, and radioactive waste
EPC	exposure point concentration	g	gram	‘I’	out of control, data rejected due to low recovery

List of Abbreviations and Acronyms (Continued)

IASPOW	Impact Area South of POW Training Facility	LC	liquid chromatography	MPA	methyl phosphonic acid
IATA	International Air Transport Authority	LCS	laboratory control sample	MPM	most probable munition
ICAL	initial calibration	LC ₅₀	lethal concentration for 50 percent population tested	MQL	method quantitation limit
ICB	initial calibration blank	LD ₅₀	lethal dose for 50 percent population tested	MR	molasses residue
ICP	inductively-coupled plasma	LEL	lower explosive limit	MRL	method reporting limit
ICRP	International Commission on Radiological Protection	LOAEL	lowest-observed-advserse-effects-level	MS	matrix spike
ICS	interference check sample	LRA	land redevelopment authority	mS/cm	millisiemens per centimeter
ID	inside diameter	LT	less than the certified reporting limit	mS/m	millisiemens per meter
IDL	instrument detection limit	LUC	land-use control	MSD	matrix spike duplicate
IDLH	immediately dangerous to life or health	LUCAP	land-use control assurance plan	MTBE	methyl tertiary butyl ether
IDM	investigative-derived media	LUCIP	land-use control implementation plan	msl	mean sea level
IDW	investigation-derived waste	max	maximum	MtD3	Montevallo shaly, silty clay loam, 10 to 40 percent slopes , severely eroded
IEUBK	Integrated Exposure Uptake Biokinetic	MB	method blank	mV	millivolts
IF	ingestion factor; inhalation factor	MCL	maximum contaminant level	MW	monitoring well
ILCR	incremental lifetime cancer risk	MCLG	maximum contaminant level goal	MWI&MP	Monitoring Well Installation and Management Plan
IMPA	isopropylmethyl phosphonic acid	MCPA	4-chloro-2-methylphenoxyacetic acid	Na	sodium
IMR	Iron Mountain Road	MCPP	2-(2-methyl-4-chlorophenoxy)propionic acid	NA	not applicable; not available
in.	inch	MCS	media cleanup standard	NAD	North American Datum
Ing	ingestion	MD	matrix duplicate	NAD83	North American Datum of 1983
Inh	inhalation	MDC	maximum detected concentration	NaMnO ₄	sodium permanganate
IP	ionization potential	MDCC	maximum detected constituent concentration	NAVD88	North American Vertical Datum of 1988
IPS	International Pipe Standard	MDL	method detection limit	NAS	National Academy of Sciences
IR	ingestion rate	mg	milligrams	NCEA	National Center for Environmental Assessment
IRDMIS	Installation Restoration Data Management Information System	mg/kg	milligrams per kilogram	NCP	National Contingency Plan
IRIS	Integrated Risk Information Service	mg/kg/day	milligram per kilogram per day	NCRP	National Council on Radiation Protection and Measurements
IRP	Installation Restoration Program	mg/kgbw/day	milligrams per kilogram of body weight per day	ND	not detected
IS	internal standard	mg/L	milligrams per liter	NE	no evidence; northeast
ISCP	Installation Spill Contingency Plan	mg/m ³	milligrams per cubic meter	ne	not evaluated
IT	IT Corporation	mh	inorganic silts, micaceous or diatomaceous fine, sandy or silt soils	NEW	net explosive weight
ITEMS	IT Environmental Management System™	MHz	megahertz	NFA	No Further Action
‘J’	estimated concentration	µg/g	micrograms per gram	NG	National Guard
JeB2	Jefferson gravelly fine sandy loam, 2 to 6 percent slopes, eroded	µg/kg	micrograms per kilogram	NGP	National Guardsperson
JeC2	Jefferson gravelly fine sandy loam, 6 to 10 percent slopes, eroded	µg/L	micrograms per liter	ng/L	nanograms per liter
JfB	Jefferson stony fine sandy loam, 0 to 10 percent slopes have strong slopes	µmhos/cm	micromhos per centimeter	NGVD	National Geodetic Vertical Datum
JPA	Joint Powers Authority	MeV	mega electron volt	Ni	nickel
K	conductivity	min	minimum	NIC	notice of intended change
K _d	soil-water distribution coefficient	MINICAMS	miniature continuous air monitoring system	NIOSH	National Institute for Occupational Safety and Health
kg	kilogram	ml	inorganic silts and very fine sands	NIST	National Institute of Standards and Technology
KeV	kilo electron volt	mL	milliliter	NLM	National Library of Medicine
K _{oc}	organic carbon partioning coefficient	mm	millimeter	NO ₃ ⁻	nitrate
K _{ow}	octonal-water partition coefficient	MM	mounded material	NPDES	National Pollutant Discharge Elimination System
KMnO ₄	potassium permanganate	MMBtu/hr	million Btu per hour	NPW	net present worth
L	liter; Lewisite (dichloro-[2-chloroethyl]sulfide)	MNA	monitored natural attenuation	No.	number
L/kg/day	liters per kilogram per day	MnO ₄ ⁻	permanganate ion	NOAA	National Oceanic and Atmospheric Administration
l	liter	MOA	Memorandum of Agreement	NOAEL	no-observed-adverse-effects-level
LAW	light anti-tank weapon	MOGAS	motor vehicle gasoline	NR	not requested; not recorded; no risk
lb	pound	MOUT	Military Operations in Urban Terrain	NRC	National Research Council
LBP	lead-based paint	MP	Military Police	NRCC	National Research Council of Canada

List of Abbreviations and Acronyms (Continued)

NRHP	National Register of Historic Places	PFT	portable flamethrower	RL	reporting limit
NRT	near real time	PG	professional geologist	RME	reasonable maximum exposure
ns	nanosecond	PID	photoionization detector	ROD	Record of Decision
N-S	north to south	PkA	Philo and Stendal soils local alluvium, 0 to 2 percent slopes	RPD	relative percent difference
NS	not surveyed	PM	project manager	RR	Range residue
NSA	New South Associates, Inc.	POC	point of contact	RRF	relative response factor
nT	nanotesla	POL	petroleum, oils, and lubricants	RSD	relative standard deviation
nT/m	nanoteslas per meter	POTW	publicly owned treatment works	RTC	Recruiting Training Center
NTU	nephelometric turbidity unit	POW	prisoner of war	RTECS	Registry of Toxic Effects of Chemical Substances
nv	not validated	PP	peristaltic pump; Proposed Plan	RTK	real-time kinematic
O ₂	oxygen	ppb	parts per billion	RWIMR	Ranges West of Iron Mountain Road
O ₃	ozone	PPE	personal protective equipment	SA	exposed skin surface area
O&G	oil and grease	ppm	parts per million	SAD	South Atlantic Division
O&M	operation and maintenance	PPMP	Print Plant Motor Pool	SAE	Society of Automotive Engineers
OB/OD	open burning/open detonation	ppt	parts per thousand	SAIC	Science Applications International Corporation
OD	outside diameter	PR	potential risk	SAP	installation-wide sampling and analysis plan
OE	ordnance and explosives	PRA	preliminary risk assessment	SARA	Superfund Amendments and Reauthorization Act
oh	organic clays of medium to high plasticity	PRG	preliminary remediation goal	sc	clayey sands; sand-clay mixtures
OH•	hydroxyl radical	PS	chloropicrin	Sch.	schedule
ol	organic silts and organic silty clays of low plasticity	PSSC	potential site-specific chemical	SCM	site conceptual model
OP	organophosphorus	pt	peat or other highly organic silts	SD	sediment
ORC	Oxygen Releasing Compound	PVC	polyvinyl chloride	SDG	sample delivery group
ORP	oxidation-reduction potential	QA	quality assurance	SDWA	Safe Drinking Water Act
OSHA	Occupational Safety and Health Administration	QA/QC	quality assurance/quality control	SDZ	safe distance zone; surface danger zone
OSWER	Office of Solid Waste and Emergency Response	QAM	quality assurance manual	SEMS	Southern Environmental Management & Specialties, Inc.
OVM-PID/FID	organic vapor meter-photoionization detector/flame ionization detector	QAO	quality assurance officer	SF	cancer slope factor
OWS	oil/water separator	QAP	installation-wide quality assurance plan	SFSP	site-specific field sampling plan
oz	ounce	QC	quality control	SGF	standard grade fuels
PA	preliminary assessment	QST	QST Environmental, Inc.	Shaw	Shaw Environmental, Inc.
PAH	polynuclear aromatic hydrocarbon	qty	quantity	SHP	installation-wide safety and health plan
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity	Qual	qualifier	SI	site investigation
Parsons	Parsons Engineering Science, Inc.	R	rejected data; resample; retardation factor	SINA	Special Interest Natural Area
Pb	lead	R&A	relevant and appropriate	SL	standing liquid
PBMS	performance-based measurement system	RA	remedial action	SLERA	screening-level ecological risk assessment
PC	permeability coefficient	RAO	remedial action objective	sm	silty sands; sand-silt mixtures
PCB	polychlorinated biphenyl	RBC	risk-based concentration; red blood cell	SM	Serratia marcescens
PCDD	polychlorinated dibenzo-p-dioxins	RCRA	Resource Conservation and Recovery Act	SMDP	Scientific Management Decision Point
PCDF	polychlorinated dibenzofurans	RCWM	Recovered Chemical Warfare Material	s/n	signal-to-noise ratio
PCE	perchloroethene	RD	remedial design	SO ₄ ⁻²	sulfate
PCP	pentachlorophenol	RDX	cyclotrimethylenetrinitramine	SOD	soil oxidant demand
PDS	Personnel Decontamination Station	ReB3	Rarden silty clay loams	SOP	standard operating procedure
PEF	particulate emission factor	REG	regular field sample	SOPQAM	U.S. EPA's <i>Standard Operating Procedure/Quality Assurance Manual</i>
PEL	permissible exposure limit	REL	recommended exposure limit	sp	poorly graded sands; gravelly sands
PERA	preliminary ecological risk assessment	RFA	request for analysis	SP	submersible pump
PES	potential explosive site	RfC	reference concentration	SPCC	system performance calibration compound
Pest.	pesticides	RfD	reference dose	SPCS	State Plane Coordinate System
PETN	pentaerythritoltetranitrate	RGO	remedial goal option	SPM	sample planning module
		RI	remedial investigation	SQRT	screening quick reference tables

List of Abbreviations and Acronyms (Continued)

Sr-90	strontium-90
SRA	streamlined human health risk assessment
SRM	standard reference material
Ss	stony rough land, sandstone series
SS	surface soil
SSC	site-specific chemical
SSHO	site safety and health officer
SSHP	site-specific safety and health plan
SSL	soil screening level
SSSL	site-specific screening level
SSSSL	site-specific soil screening level
STB	supertropical bleach
STC	source-term concentration
STD	standard deviation
STEL	short-term exposure limit
STL	Severn-Trent Laboratories
STOLS	Surface Towed Ordnance Locator System®
Std. units	standard units
SU	standard unit
SUXOS	senior UXO supervisor
SVOC	semivolatile organic compound
SW	surface water
SW-846	U.S. EPA’s <i>Test Methods for Evaluating Solid Waste: Physical/Chemical Methods</i>
SWMU	solid waste management unit
SWPP	storm water pollution prevention plan
SZ	support zone
TAL	target analyte list
TAT	turn around time
TB	trip blank
TBC	to be considered
TCA	trichloroethane
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorodibenzofurans
TCE	trichloroethene
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TDEC	Tennessee Department of Environment and Conservation
TDGCL	thiodiglycol
TDGCLA	thiodiglycol chloroacetic acid
TEA	triethylaluminum
Tetryl	trinitrophenylmethylnitramine
TERC	Total Environmental Restoration Contract
THI	target hazard index
TIC	tentatively identified compound
TLV	threshold limit value
TN	Tennessee
TNT	trinitrotoluene
TOC	top of casing; total organic carbon

TPH	total petroleum hydrocarbons
TR	target cancer risk
TRADOC	U.S. Army Training and Doctrine Command
TRPH	total recoverable petroleum hydrocarbons
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, and disposal facility
TWA	time-weighted average
UCL	upper confidence limit
UCR	upper certified range
‘U’	not detected above reporting limit
UIC	underground injection control
UF	uncertainty factor
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAEC	U.S. Army Environmental Center
USAEHA	U.S. Army Environmental Hygiene Agency
USACMLS	U.S. Army Chemical School
USAMPS	U.S. Army Military Police School
USATCES	U.S. Army Technical Center for Explosive Safety
USATEU	U.S. Army Technical Escort Unit
USATHAMA	U.S. Army Toxic and Hazardous Material Agency
USC	United States Code
USCS	Unified Soil Classification System
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
UTL	upper tolerance level; upper tolerance limit
UXO	unexploded ordnance
UXOQCS	UXO Quality Control Supervisor
UXOSO	UXO safety officer
V	vanadium
VC	vinyl chloride
VOA	volatile organic analyte
VOC	volatile organic compound
VOH	volatile organic hydrocarbon
VQlfr	validation qualifier
VQual	validation qualifier
VX	nerve agent (O-ethyl-S-[diisopropylaminoethyl]-methylphosphonothiolate)
WAC	Women’s Army Corps
Weston	Roy F. Weston, Inc.
WP	installation-wide work plan
WRS	Wilcoxon rank sum
WS	watershed
WSA	Watershed Screening Assessment
WWI	World War I
WWII	World War II

XRF	x-ray fluorescence
yd ³	cubic yards

Final

**Remedial Investigation Report
Range J – Pelham Range, Parcel 202(7)**

**Volume II of II
Appendices D through L**

**Fort McClellan
Calhoun County, Alabama**

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**Task Order CK05
Contract No. DACA21-96-D-0018
Shaw Project No. 774645**

September 2004

Revision 1